BULLETIN OF THE IMPERIAL INSTITUTE

A QUARTERLY RECORD OF PROGRESS IN TROPICAL AGRICULTURE AND INDUSTRIES AND THE COMMERCIAL UTILISATION OF THE NATURAL RESOURCES OF THE DOMINIONS, COLONIES AND INDIA

EDITED BY THE DIRECTOR AND PREPARED BY THE SCIENTIFIC AND TECHNICAL STAFF OF THE IMPERIAL INSTITUTE AND BY OTHER CONTRIBUTORS

VOL. XIX. 1921

LONDON
JOHN MURRAY, ALBEMARLE STREET, W.

ERRATA

Page 68, lines 11, 12, *for* BULLETIN, 1919, **17**, 249, *read* BULLETIN, 1920, **18**.
,, 183, line 2, for *Cymbopogon* read *Andropogon*.

Printed by Hazell, Watson & Viney, Ld., London and Aylesbury, England.

BULLETIN OF THE IMPERIAL INSTITUTE

VOL. XIX. 1921

CONTENTS

CONTENTS

SPECIAL ARTICLES

GENERAL ARTICLES

CONTENTS

NOTES

CONTENTS

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS

THE IMPERIAL INSTITUTE

OF THE

UNITED KINGDOM, THE COLONIES AND INDIA

THE Imperial Institute was erected at South Kensington as the National Memorial of the Jubilee of Queen Victoria, by whom it was opened in May 1893.

The principal object of the Institute is to promote the utilisation of the commercial and industrial resources of the Empire: (i) by arranging comprehensive exhibitions of natural products, especially of the Dominions, Colonies and India; and (ii) by providing for their investigation, and for the collection and dissemination of scientific, technical and commercial information relating to raw materials.

Until the end of 1902 the Imperial Institute was managed by a Governing Body, of which H.R.H. the Prince of Wales (afterwards King Edward VII.) was President, and an Executive Council, including representatives of the Indian Empire and of all the British Colonies and Dependencies. In 1900 the building became the property of H.M. Government, by whom the western portion and galleries were leased to the Governing Body of the Imperial Institute, the greater part of the eastern and central portions being assigned, subject to rights of usage, for occupation by the University of London. In July 1902 an Act of Parliament was passed transferring the management of the Imperial Institute to the Board of Trade, assisted by an Advisory Committee including representatives of the Dominions, Colonies and India, as well as of the Colonial and India Offices, the Board of Agriculture and the Board of Trade.

Under a subsequent arrangement between the Departments concerned, the Colonial Office became chiefly concerned with the management of the Imperial Institute.

In April 1916 the Imperial Institute (Management) Act was passed transferring the property and management of the Imperial Institute to the Secretary of State for the Colonies. The Act provides for the appointment of an Executive Council consisting of twenty-five members, nominated by the Board of Trade, the Secretary of State for India (two each), the President of the Board of Agriculture and Fisheries, the Government of India, the Governments of the several Dominions (one each), and the Secretary of State for the Colonies (fourteen). A list of the present members of the Council is given on pp. xi and xii and also of the various Committees which have been appointed (pp. xii–xvii).

The staff of the Imperial Institute includes officers with special qualifications in the sciences of chemistry, botany, geology and mineralogy, and in certain branches of technology, in their relation to commerce and to the industrial utilisation of raw materials.

The following are the principal departments of the Institute:

Public Exhibition Galleries.—The collections of raw materials, etc., illustrative of the industrial and commercial resources of the Dominions, Colonies and India, are arranged, together with other exhibits, on a geographical system in the public galleries of the Imperial Institute. The galleries are open free to the public, daily (except on Sundays, Good Friday and Christmas Day), from 10 a.m. to 5 p.m. in summer, and from 10 a.m. to 4 p.m. in winter.

The following British Dominions, Colonies and Dependencies are represented by Collections, which are in charge of Technical Superintendents:

Canada, Newfoundland; Jamaica, Turks and Caicos Islands, British Honduras, British Guiana, Bahamas, Trinidad and Tobago, Barbados, Windward Islands, Leeward Islands, Bermuda; Falkland Islands; New South

Wales, Victoria, Queensland, Tasmania, South Australia, Western Australia, Papua, Northern Territory, New Zealand; Fiji, Western Pacific Islands; Union of South Africa, Rhodesia, Nyasaland, St. Helena; Gambia, Sierra Leone, Gold Coast, Nigeria; Kenya Colony, Zanzibar and Pemba; Uganda; Somaliland; Egypt, Sudan; Malta; Cyprus; Ceylon; Hong Kong; Mauritius; Seychelles; Straits Settlements, the Federated Malay States; and the Indian Empire.

Arrangements are made to conduct schools and educational institutions through the Galleries and to explain the exhibits. A guide-lecturer has been appointed to give demonstrations in the Galleries at stated times.

A Central Stand for the distribution of publications and an Enquiry Office have been opened in the main gallery to provide for the supply of general information and the distribution of literature. Handbooks, pamphlets, circulars, etc., containing information relating to the commerce, agriculture, mining and other industries of the Dominions and Colonies, and also in regard to emigration, are available for free distribution or for sale. Lists of the publications available for distribution or sale are provided, and the principal Colonial and Indian newspapers may be seen on application.

Scientific and Technical Research Department.—The technical laboratories and workrooms of this Department were established in order to provide for the investigation of new or little-known raw materials from the Dominions, Colonies and India, and of known products from new sources, with a view to their utilisation in commerce. Materials investigated by the Department are in promising cases submitted to further technical trials by manufacturers and other experts, and finally are commercially valued.

The work of this Department is chiefly initiated by the Home, Dominion and Colonial Governments and the Government of India. Arrangements have also been made by the Department of Overseas Trade whereby British representatives abroad may transmit to the Institute,

for investigation, such raw materials of the countries to which they are appointed as are likely to be of interest to British manufacturers and merchants.

Special analyses and investigations are undertaken for firms or private persons in any part of the Empire on payment of appropriate charges. Application for such investigations should be made, in writing, to the Director.

A Reference Sample Room is maintained in this Department, in which are arranged samples of the principal raw materials which have been investigated and valued commercially during recent years, and as to which full information can be supplied. A reference collection of standard raw materials of commerce is also available for inspection.

The Department works in co-operation with the Agricultural, Mines and other Technical Departments in the Dominions, Colonies and India, whose operations it supplements by undertaking investigations and enquiries of a special scientific or technical character connected with agricultural or mineral development, as well as enquiries relating to the composition and commercial valuation of products (animal, vegetable or mineral) which can be more efficiently conducted at home in consultation with manufacturers and merchants, with a view to the local utilisation of these products or to their export.

A large number of reports on these subjects have been made to the Governments of the Dominions, the Colonies and India, a first instalment of which was printed in a volume of *Technical Reports and Scientific Papers*, published in 1903. A series of Selected Reports is issued in the Miscellaneous Series of Colonial Reports which are presented to Parliament (see p. viii). Summaries of reports are published in the BULLETIN OF THE IMPERIAL INSTITUTE (see p. vi).

Mineral Surveys are conducted in countries of which the mineral resources are little known. All minerals found that are likely to be of commercial importance are forwarded to the Imperial Institute, where they are examined and their composition and commercial value

ascertained. Reports on the results of mineral exploration in Ceylon, Northern Nigeria, Southern Nigeria, and Nyasaland have been printed in the Miscellaneous Series of Colonial Reports and presented to Parliament. The work of the Imperial Institute on minerals is carried on with the advice of the Committee on Mineral Resources (see p. xvi).

Technical Information Bureau.—This is a branch of the Scientific and Technical Research Department which has been formed to deal with the large and increasing number of enquiries received by the Imperial Institute from manufacturers, merchants and others, throughout the Empire. The Bureau has devoted special attention to questions relating to the raw materials required for the industries of the Empire. It has supplied technical information to enquirers, and has issued circulars and pamphlets dealing with various problems in connection with the supply and disposal of raw materials of all kinds.

Indian Trade Enquiry.—The Secretary of State for India has requested the Committee for India of the Institute to enquire into and report on the possibilities of extending the industrial and commercial utilisation of Indian raw materials in this country and elsewhere in the Empire. Special Committees have been appointed to deal with the more important groups of Indian materials, to consider the results of investigations and enquiries already conducted at the Imperial Institute, and to obtain the views of leading merchants, manufacturers, and other users of the raw materials of India. A number of reports have already been furnished to the India Office, and these are now in course of publication as a series of volumes by Mr John Murray (see p. viii).

Tropical African Services Course.—Courses of instruction in certain specified subjects are given at the Imperial Institute to candidates selected by the Colonial Office for

administrative appointments in East and West Africa. Instruction in these Courses in the subject of Tropical Economic Products is given by a member of the Staff of the Imperial Institute.

Library, Reading-Rooms and Map-Room.—The library and reading-rooms of the Imperial Institute contain a large collection of works of reference, and are regularly supplied with the more important official publications, and with many of the principal newspapers and periodicals of the United Kingdom, the Dominions, the Colonies, India and Foreign Countries. Special attention is given to publications relating to tropical agriculture and forestry, mineral resources, and the production and utilisation of raw materials.

The map-room, which adjoins the reading-rooms, is provided with a large collection of recent maps of the Dominions, the Colonies and India, which can be seen on application.

Conference Rooms.—These rooms, specially decorated and furnished, are reserved on the principal floor for use by representatives of the Dominions and Colonies and for meetings and receptions.

The Cowasjee Jehangier Hall.—The Bhownaggree corridor and rooms in connection with the Cowasjee Jehangier Hall are in the occupation of the Indian Section of the Imperial Institute, whilst the Hall is available for lectures, meetings, etc.

Publications

Bulletin of the Imperial Institute.—The BULLETIN is published quarterly by Mr. John Murray, 50A, Albemarle Street, London, and may be purchased through any bookseller. It contains records of the principal investigations carried out at the Imperial Institute, and special articles

chiefly relating to the industrial utilisation of raw materials and progress in tropical agriculture.

Handbooks to the Commercial Resources of the Tropics.—The Secretary of State for the Colonies has authorised the preparation of a series of handbooks dealing with the Commercial Resources of the Tropics, with special reference to West Africa. The handbooks are edited by the Director of the Imperial Institute and published by Mr. John Murray. The volumes already issued are: *The Agricultural and Forest Products of British West Africa*, by Gerald C. Dudgeon, Consulting Agriculturist, Ministry of Agriculture, Egypt, and lately Inspector of Agriculture for British West Africa; *Cocoa: Its Cultivation and Preparation*, by W. H. Johnson, F.L.S., Director of Agriculture in Southern Nigeria; *Rubber: Its Sources, Cultivation and Preparation*, by Harold Brown, Technical Superintendent, Scientific and Technical Department, Imperial Institute; and *Cotton and other Vegetable Fibres: their Production and Utilisation*, by Ernest Goulding, D.Sc., F.I.C., Scientific and Technical Department, Imperial Institute, (2nd edition).

Monographs on Industrial Resources.—The Imperial Institute has devoted special attention to the question of securing the utilisation in the United Kingdom of the large quantities of materials produced within the Empire which before the war were exported chiefly to foreign countries. It is intended to deal with this subject in a series of Monographs. In order to call attention to the subject of oil seeds, a monograph, entitled *Oil Seeds and Feeding Cakes*, has been issued. This book, which is published by Mr. John Murray, deals with the production and utilisation of copra, palm kernels, ground nuts, sesame seed and mowra seed, and the oils and feeding cakes obtained from them.

The Mineral Resources Committee of the Imperial Institute have arranged for the publication of a series of monographs on mineral resources with special reference to those of the British Empire. The following monographs

have been published, and may be obtained from the Imperial Institute: Zinc Ores, Manganese Ores, Tin Ores, Tungsten Ores, Platinum Metals, Coal, Lead Ores, and Chromium Ore.

A Map and Diagrams of the Chief Metal Resources of the Empire, prepared at the Imperial Institute with the advice of the Imperial Institute Committee on Mineral Resources, is now issued. The chief British countries of occurrence and production of the principal minerals are shown on the map. The diagrams give the outputs of these countries for 1915 in relation to the production of other countries of the world. The metals dealt with are: gold, silver, platinum, copper, tin, lead, zinc, antimony, aluminium, bismuth, iron, manganese, chromium, nickel, tungsten, molybdenum, vanadium, and mercury.

The map and diagrams are mounted on linen and folded. The publication is obtainable from the Imperial Institute.

Reports of the Indian Trade Enquiry.—The Reports of the Special Committees appointed in connection with the Indian Trade Enquiry (see p. v) are now in course of publication, the first four volumes of the series being *Hides and Skins*, *Oil Seeds*, *Rice*, and *Timbers and Paper Materials*. The reports contain important information and recommendations regarding the extension of the industrial and commercial utilisation of Indian raw materials, as well as statements on the general position of each commodity prepared at the Imperial Institute for the use of the Committees. The volumes are published by Mr. John Murray.

Selected Reports from the Scientific and Technical Department.—These reports, which are issued in the Miscellaneous Series of Colonial Reports, contain a summary of the results of technical and commercial investigation of certain raw materials conducted in the Scientific and Technical Research Department of the Imperial Institute since 1903. Five of these Selected Reports have been published: Part I. "Fibres" (1909); Part II. "Gums and Resins" (1909);

Part III. "Foodstuffs" (1910); Part IV. "Rubber and Gutta Percha" (1912); Part V. "Oilseeds, Oils, Fats and Waxes" (1914).

Organisations with Headquarters at the Institute

International Association for Tropical Agriculture, British Section.—The object of this Association, the Central Bureau of which is in Paris, is to promote the scientific and practical study of all questions connected with tropical agriculture, including the development and utilisation of natural resources, and to arrange for International Congresses. The British Section has its headquarters at the Imperial Institute. Members of the British Section receive the Bulletin of the Imperial Institute and are permitted to use the library and reading-rooms of the Imperial Institute.

Overseas Nursing Association.—An office on the mezzanine floor has been allotted to this Association, the principal object of which is the selection of trained hospital and private nurses for service in the Crown Colonies and Dependencies.

African Society.—This Society has been provided temporarily with an office at the Imperial Institute, and meetings of the Society are held there.

THE IMPERIAL INSTITUTE

Trustees

THE FIRST COMMISSIONER OF HIS MAJESTY'S TREASURY.
THE SECRETARY OF STATE FOR THE COLONIES.
THE SECRETARY OF STATE FOR INDIA.
THE PRESIDENT OF THE BOARD OF TRADE.

Executive Council

(Appointed under the provisions of the Imperial Institute (Management) Act, 1916)

	Appointed by
The Right Hon. LORD ISLINGTON, G.C.M.G., D.S.O. (*Chairman.*)	The Colonial Office.
The Right Hon. VISCOUNT BURNHAM, C.H.	
The Right Hon. LORD EMMOTT, G.C.M.G., G.B.E.	
Sir EDWARD DAVSON.	
WYNDHAM R. DUNSTAN, Esq., C.M.G., F.R.S., Director, Imperial Institute.	
A. FIDDIAN, Esq., Colonial Office.	
Sir ALGERNON FIRTH, Bart., lately President, Association of Chambers of Commerce.	
G. E. A. GRINDLE, Esq., C.B., C.M.G., Colonial Office.	
Sir R. M. KINDERSLEY, G.B.E., Director, Bank of England.	
D. O. MALCOLM, Esq., Director, British South Africa Company.	
Sir OWEN PHILIPPS, G.C.M.G., M.P., Chairman, Union-Castle Steamship Company.	
Sir WILLIAM TAYLOR, K.C.M.G.	
Sir R. THRELFALL, K.B.E., F.R.S., Member, Advisory Council, Dept. of Scientific and Industrial Research.	
(One vacancy).	

	Appointed by
P. W. L. Ashley, Esq., C.B., Board of Trade. R. W. Matthew, Esq., Department of Overseas Trade.	The Board of Trade.
Sir J. P. Hewett, G.C.S.I., K.B.E., C.I.E., lately Lieut.-Governor, United Provinces, India. Sir L. J. Kershaw, K.C.S.I., C.I.E., India Office.	The Secretary of State for India.
Sir Daniel Hall, K.C.B., F.R.S., Ministry of Agriculture.	The Ministry of Agriculture and Fisheries.
Sir R. W. Carlyle, K.C.S.I., C.I.E., lately Member, Governor-General's Council, India.	The Government of India.
The Hon. Sir G. H. Perley, K.C.M.G., High Commissioner for Canada.	The Government of the Dominion of Canada.
	The Government of the Commonwealth of Australia.
Sir R. A. Blankenberg, K.B.E., Acting High Commissioner for South Africa.	The Government of the Union of South Africa.
The Hon. Sir James Allen, K.C.B., High Commissioner for New Zealand.	The Government of the Dominion of New Zealand.
The Hon. Sir Edgar Bowring, High Commissioner for Newfoundland.	The Government of Newfoundland.

Secretary to the Council, H. M. Lidderdale, Esq., Imperial Institute.

Director of the Imperial Institute

Wyndham R. Dunstan, Esq., C.M.G., M.A., LL.D., F.R.S.

Finance and General Purposes Committee

The Right Hon. Lord Islington, G.C.M.G., D.S.O. (*Chairman*).
The Right Hon. Viscount Burnham, C.H.
Sir R. W. Carlyle, K.C.S.I., C.I.E. (*Vice-Chairman*).
A. Fiddian, Esq.
Sir Algernon Firth, Bart.
G. E. A. Grindle, Esq., C.B., C.M.G.
Sir J. P. Hewett, G.C.S.I., K.B.E., C.I.E.
D. O. Malcolm, Esq.
Sir William Taylor, K.C.M.G.

Committees for the Dominions

Committee for Canada

The Hon. Sir G. H. PERLEY, K.C.M.G., High Commissioner for Canada (*Chairman*).

J. G. COLMER, Esq., C.M.G., formerly Secretary to the High Commissioner's Office.

Sir R. M. KINDERSLEY, G.B.E., Governor, Hudson's Bay Company.

J. H. PLUMMER, Esq., Chairman, Dominion Steel Corporation.

Sir KEITH PRICE, Messrs. Price & Pierce.

Committee for Australia

Sir GORDON CAMPBELL, K.B.E., Messrs. W. Weddel & Co., Ltd.

Captain Sir ROBERT MUIRHEAD COLLINS, R.N., C.M.G., lately Official Secretary to the Commonwealth, in London.

E. V. REID, Esq., Messrs. Dalgety & Co.

Committee for New Zealand

The Hon. Sir JAMES ALLEN, K.C.B., High Commissioner for New Zealand (*Chairman*).

W. ACTON ADAMS, Esq., J.P.

JAMES COATES, Esq.

G. F. GEE, Esq.

R. D. DOUGLAS McLEAN, Esq.

ALEXANDER MICHIE, Esq.

Sir JAMES MILLS, K.C.M.G.

W. H. MONTGOMERY, Esq., C.B.E.

R. H. NOLAN, Esq., C.B.E.

Committee for the Union of South Africa and Rhodesia

Sir R. A. BLANKENBERG, K.B.E., Acting High Commissioner for the Union of South Africa (*Chairman*).

A. CANHAM, Esq., Trades Commissioner for the Union of South Africa.

D. O. MALCOLM, Esq., British South Africa Company.

C. W. S. MAUDE, Esq., British South Africa Company.

WILLIAM MOSENTHAL, Esq., Messrs. Mosenthal, Sons & Co.

WILLIAM S. SOPER, Esq., M.A., Messrs. Davis & Soper, Ltd.

Committee for India

Sir C. C. McLEOD, Chairman, East India Section, London Chamber of Commerce (*Chairman*).

Sir HARVEY ADAMSON, K.C.S.I., lately Lieut.-Governor, Burma.

A. YUSUF ALI, Esq., C.B.E., late Indian Civil Service.

Sir CHARLES H. ARMSTRONG, Messrs. Lyon, Lord & Co.

The Right Hon. LORD CABLE, Messrs. Bird & Co.

Sir R. W. CARLYLE, K.C.S.I., C.I.E., lately Member of Governor-General's Council, India.

The Right Hon. LORD CARMICHAEL, G.C.S.I., G.C.I.E., K.C.M.G., lately Governor of Bengal.

D. T. CHADWICK, Esq., C.I.E., Indian Trade Commissioner.

Sir J. P. HEWETT, G.C.S.I., K.B.E., C.I.E., lately Lieut.-Governor, United Provinces, India.

Sir L. J. KERSHAW, K.C.S.I., C.I.E., India Office.

Sir JAMES R. DUNLOP SMITH, K.C.S.I., K.C.V.O., C.I.E., India Office.

Sir GEORGE SUTHERLAND, Messrs. Begg, Dunlop & Co.

Indian Trade Enquiry; Special Committees

Jute, Cotton, Wool and other Fibres

Sir C. C. McLEOD (*Chairman*).

Sir CHARLES H. ARMSTRONG.

GEORGE BONAR, Esq., Messrs. Low & Bonar.

Sir R. W. CARLYLE, K.C.S.I., C.I.E.

WYNDHAM R. DUNSTAN, Esq., C.M.G., LL.D., F.R.S.

G. C. HODGSON, Esq., Messrs. Hodgson & Co.

J. A. HUTTON, Esq., lately Chairman, British Cotton Growing Association.

GEORGE MALCOLM, Esq., C.B.E., Messrs. Ralli Bros.

Prof. J. A. TODD, lately Secretary, Empire Cotton Growing Committee.

Sir FRANCIS YOUNGHUSBAND, K.C.I.E.

Dr. S. E. CHANDLER, Imperial Institute (*Secretary*).

Food Grains

Sir CHARLES H. ARMSTRONG.

Sir J. P. HEWETT, G.C.S.I., K.B.E., C.I.E.

A. E. HUMPHRIES, Esq., Vice-President, National Association of British and Irish Millers.

Dr. T. A. HENRY (*Secretary*).

Gums, Resins and Essential Oils

Sir HARVEY ADAMSON, K.C.S.I. (*Chairman*).

A. BIGLAND, Esq., M.P.

F. W. F. CLARK, Esq., Messrs. Robert Ingham Clark & Co., Ltd.

WYNDHAM R. DUNSTAN, Esq., C.M.G., LL.D., F.R.S.

Lieut.-Col. S. H. GODFREY, C.I.E.

Sir JAMES R. DUNLOP SMITH, K.C.S.I., K.C.V.O., C.I.E.

Dr. T. A. HENRY (*Secretary*).

H. J. JEFFERY, Esq. (*Assistant Secretary*).

Drugs, Tobacco and Spices

Wyndham R. Dunstan, Esq., C.M.G., LL.D., F.R.S. (*Chairman*).
Sir Harvey Adamson, K.C.S.I.
Lieut.-Col. S. H. Godfrey, C.I.E.
Sir Edward Rosling.
Sir James R. Dunlop Smith, K.C.S.I., K.C.V.O., C.I.E.
Dr. T. A. Henry (*Secretary*).
H. J. Jeffery, Esq. (*Assistant Secretary*).

Oil Seeds

Sir Charles H. Armstrong (*Chairman*).
A. Bigland, Esq., M.P.
Sir J. P. Hewett, G.C.S.I., K.B.E., C.I.E.
J. W. Pearson, Esq., Chairman, Seed Crushers' Association.
Dr. T. A. Henry (*Secretary*).

Timber and Paper Materials

Sir R. W. Carlyle, K.C.S.I., C.I.E. (*Chairman*).
Wyndham R. Dunstan, Esq., C.M.G., LL.D., F.R.S.
Lewis Evans, Esq., F.S.A., F.R.A.S., President, Paper-makers' Association.
Sir C. C. McLeod.
Lawrence Mercer, Esq., C.I.E., lately President, Forest Research Institute, Dehra Dun, India.
Dr. S. E. Chandler (*Secretary*).

Technical Committees

Raw Materials Committee

(Nominated by the Association of British Chambers of Commerce)

Sir Algernon Firth, Bart. (*Chairman*), lately President, Association of British Chambers of Commerce.
F. W. Astbury, Esq., M.P., Dr. Alfred Rée, — Manchester Chamber of Commerce.
Sir Cecil W. N. Graham, W. F. Russell, Esq., — Glasgow Chamber of Commerce.
G. A. Moore, Esq., J. Pickering-Jones, Esq., — Liverpool Chamber of Commerce.
A. C. Powell, Esq., Bristol Chamber of Commerce.
A. M. Samuel, Esq., M.P., Norwich Chamber of Commerce.
H. H. Sissons, Esq., Hull Chamber of Commerce.
Dr. J. E. Stead, F.R.S., Middlesbrough Chamber of Commerce.
H. L. Symonds, Esq., London Chamber of Commerce.
Alexander Johnston, Esq., Federation of British Industries.
R. B. Dunwoody, Esq., O.B.E., Association of British Chambers of Commerce. H. Brown, Esq., Imperial Institute. — *Secretaries.*

Hides and Tanning Materials Committee

WYNDHAM R. DUNSTAN, Esq., C.M.G., LL.D., F.R.S. (*Chairman*).
Sir HARVEY ADAMSON, K.C.S.I.
Sir W. EARNSHAW COOPER, C.I.E., Messrs. Cooper, Allen & Co.
C. W. DAWSON, Esq., Messrs. Allen Bros. & Co.
Sir H. P. DENSHAM, K.B.E., lately Chairman, United Tanners' Federation of Great Britain and Ireland.
Lieut.-Col. S. H. GODFREY, C.I.E., lately Political Agent, Baghelkhand, Central India.
Sir CECIL W. N. GRAHAM, Messrs. Graham & Co.
W. L. INGLE, Esq., Chairman, United Tanners' Federation of Great Britain and Ireland.
C. J. LONGCROFT, Esq., Messrs. D. Sassoon & Co.
SAMUEL MILLAR, Esq., Messrs. Millar's, Ltd., Glasgow.
H. BROWN, Esq., Imperial Institute (*Secretary*).

Mineral Resources Committee

The Right Hon. VISCOUNT HARCOURT, D.C.L. (*Chairman*).
Admiral Sir EDMOND SLADE, K.C.I.E., K.C.V.O. (Nominated by the Admiralty.) (*Vice-Chairman.*)
EDMUND G. DAVIS, Esq.
Prof. C. H. DESCH, D.Sc., Professor of Metallurgy, University of Sheffield.
WYNDHAM R. DUNSTAN, Esq., C.M.G., LL.D., F.R.S.
Captain A. L. ELSWORTHY, Military Intelligence Department, War Office. (Nominated by the War Office.)
Prof. J. W. GREGORY, D.Sc., F.R.S., Professor of Geology, University of Glasgow, formerly Director of Geological Survey, Victoria, Australia.
Sir ROBERT HADFIELD, Bart., F.R.S., formerly President, Iron and Steel Institute.
A. HUTCHINSON, Esq., O.B.E., M.A., Ph.D., Department of Mineralogy, University of Cambridge.
W. W. MOYERS, Esq., Messrs. H. A. Watson & Co., Ltd.
J. F. RONCA, Esq., M.B.E., A.R.C.Sc., A.I.C., Board of Trade. (Nominated by the Board of Trade.)
R. ALLEN, Esq., M.A., B.Sc., Imperial Institute (*Secretary*).

Ceylon Rubber Research Committee

WYNDHAM R. DUNSTAN, Esq., C.M.G., LL.D., F.R.S. (*Chairman*).
Sir STANLEY BOIS, President, Ceylon Association in London.
Sir EDWARD ROSLING, lately Chairman, Rubber Growers' Association.
PERCY ROSLING, Esq., Henley's Telegraph Works Company.
W. A. WILLIAMS, Esq., North British Rubber Company.
J. V. WORTHINGTON, Esq., Dunlop Rubber Company.
H. BROWN, Esq. (*Secretary*).

Silk Production Committee

Sir FRANK WARNER,[1] K.B.E., Messrs. Warner & Sons (*Chairman*), Vice-President, Silk Association.
Sir HENRY BIRCHENOUGH, Bart., K.C.M.G.
NORTON BRETON,[1] Esq., Messrs. Henckell, Du Buisson & Co.
WYNDHAM R. DUNSTAN, Esq., C.M.G., LL.D., F.R.S.
FRANCIS DURANT,[1] Esq., Messrs. Durant, Bevan & Co.
FRANK J. FARRELL, Esq., M.Sc., Messrs. Grout & Co., Ltd., Vice-President, Silk Association.
WILLIAM FROST,[1] Esq., J.P., Messrs. W. Frost & Sons, Ltd.
Prof. H. MAXWELL LEFROY, M.A., Imperial College of Science and Technology.
J. SUGDEN SMITH,[1] Esq., Messrs. John Hind & Co., Ltd.
RICHARD SNOW,[1] Esq., Messrs. Windley & Co., Vice-President, Silk Association.
A. JOHN SOLLY,[1] Esq., J.P., Messrs. Reade & Co., Ltd., Vice-President, Silk Association.
H. SOLMAN, Esq., Messrs. John Heathcoat & Co.
WILLIAM STOKES, Esq., Messrs. Lewis Balfour & Co.
WILLIAM WATSON,[1] Esq., Messrs. Lister & Co., Ltd., Vice-President, Silk Association.
Dr. S. E. CHANDLER (*Secretary*).

[1] *Nominated by the Silk Association of Great Britain and Ireland.*

Timbers Committee

H. D. SEARLES-WOOD, Esq., F.R.I.B.A. (*Chairman*).
W. E. VERNON CROMPTON, Esq., F.R.I.B.A.
DIGBY L. SOLOMON, Esq., B.Sc., A.R.I.B.A.
(Nominated by the Royal Institute of British Architects.)

WALTER BIRCH, Esq., Messrs. Wm. Birch, Ltd.
W. H. SADGROVE, Esq., Messrs. Sadgrove & Co.
(Nominated by the National Federation of Furniture Manufacturers.)

W. LAWTON GOODMAN, Esq. (Nominated by the Institute of British Carriage and Automobile Manufacturers.)

Major RALPH J. HOLLIDAY, M.C., Messrs. Holliday & Greenwood, Ltd.
H. T. HOLLOWAY, Esq., Messrs. Holloway Bros. (London), Ltd.
(Nominated by the Institute of Builders.)

J. W. LORDEN, Esq., M.P., Timber Sub-Committee, Empire Development Parliamentary Committee.

C. J. MORGAN, Esq., Messrs. Foy, Morgan & Co.
JAMES RICHARDSON, Esq.
(Nominated by the Timber Trade Federation of the United Kingdom.)

PERCY PRESTON, Esq. (Nominated by the Carpenters' Company.)
WYNDHAM R. DUNSTAN, Esq., C.M.G., LL.D., F.R.S.
Sir KEITH PRICE, Messrs. Price & Pierce, Ltd.
Dr. S. E. CHANDLER (*Secretary*).

[In addition to the Committees in which their names are included, the Chairman of the Executive Council and the Director of the Imperial Institute are *ex-officio* Members of all Committees.]

LIST OF STAFF

Director: WYNDHAM R. DUNSTAN, C.M.G., M.A., LL.D., F.R.S.

Secretary to the Executive Council and Administrative Assistant to the Director: H. M. LIDDERDALE, B.A. (Oxon).

Assistant Secretary and Establishment Officer: Commander the Hon. SERELD HAY, O.B.E., R.N. (ret.).

Scientific and Technical Research Department and Technical Information Bureau.—*Superintendents:* H. BROWN; E. GOULDING, D.Sc. (Lond.), F.I.C.; S. E. CHANDLER, D.Sc. (Lond.), A.R.C.Sc., F.L.S. (*Acting*); R. ALLEN, M.A. (Cantab.), B.Sc. (Lond.), M.I.M.M. *Assistant Superintendents:* S. J. JOHNSTONE, B.Sc. (Lond.), A.I.C.; J. R. FURLONG, Ph.D. (Würzburg), A.I.C. *Principal Assistant:* O. D. ROBERTS, F.I.C.

Library.—*Officer in Charge:* H. J. JEFFERY, A.R.C.Sc., F.L.S. (*Acting*).

Public Exhibition Galleries.—COLONIAL AND INDIAN COLLECTIONS: *Senior Technical Superintendent:* H. SPOONER (*Acting*).

Other Members of the Scientific and Technical Staff

H. BENNETT, B.Sc. (Lond.).
G. S. BOULGER, F.L.S., F.G.S.
F. BOULTON.
G. T. BRAY, A.I.C.
W. S. DAVEY.
D. DEIGHTON.
F. L. ELLIOTT.
A. T. FAIRCLOTH.
F. FERRABOSCHI, M.A. (Cantab.), A.I.C., F.C.S.
R. C. GROVES, M.Sc. (Birm.), A.I.C.
E. HALSE, A.R.S.M., M.I.M.M.
P. HARRIS, B.Sc. (Lond.).
G. E. HOWLING, B.Sc. (Lond.).
H. T. ISLIP, A.I.C., F.C.S.
A. B. JACKSON, A.L.S.
B. E. LONG, B.A. (Cantab.).
F. MAJOR, B.Sc. (Lond.), A.I.C.
E. C. MOORE.
J. A. NELSON, B.Sc. (Lond.).
F. W. ROLFE.
P. F. C. SOWTER, B.Sc. (Lond.) A.R.C.Sc., A.I.C.
W. O. R. WYNN, A.I.C.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Dominion, Colonial and Indian Governments.

NEW ZEALAND WASTE TIMBER FOR PAPER-MAKING

In all countries in which forestry and timber-cutting operations are carried on, large quantities of wood are wasted. A considerable amount is lost during the cutting of the trees, *e.g.* by leaving too long a stump to rot in the ground, by discarding trees broken in falling, by the breaking of young trees by falling timber, and by the rejection of immature and defective trees after cutting and of large limbs and tree tops. It has been estimated that in the United States the annual logging waste amounts to 1,500,000,000 cubic feet of wood, or 15 to 20 per cent. of the timber cut ("By-products of the Lumber Industry," *Special Agents Series*, No. 110, 1916, *U.S. Bur. of Foreign and Domestic Commerce*). Some of this is ultimately recovered and utilised in various ways, but by far the greater part becomes destroyed by decay, fire and land-clearing operations. Further loss is entailed in the saw-mill, the annual waste in the United States, inclusive of slabs and edgings, being estimated at about 4,000,000,000 cubic feet of wood. In countries such as New Zealand, the quantity of waste wood is naturally much less, but in view of the relatively small reserves of timber in that country, the necessity for conservation becomes of still greater importance. The Lands and Survey Department in Wellington estimates that the approximate normal annual cut of timber in New Zealand is 360,000,000 super feet and the total quantity of waste produced in the sawmills, in the form of sawdust and slabs, is about 15,000,000 cubic feet. Of the latter quan-

tity not more than 2,000,000 cubic feet is used as fuel, the remainder being entirely wasted.

In addition to its common use as fuel, waste wood is utilised in the United States and Canada to some extent in the manufacture of paper-pulp and for the production of acetone, alcohol, etc. by destructive distillation. The question of utilising the waste wood produced in New Zealand for these purposes was considered at the Imperial Institute during the war, but owing to the conditions then obtaining the New Zealand Forestry Branch were compelled to defer action until after the war. The matter is now being taken up and eight New Zealand timbers have been examined at the Imperial Institute with a view to determining their value as paper-making materials.

The timbers submitted for examination were as follows: (1) *Fagus* (*Nothofagus*) *Solandri*; (2) *Fagus* (*Nothofagus*) *cliffortioides*; (3) *Fagus* (*Nothofagus*) *Menziesii*; (4) *Weinmannia racemosa*; (5) *Fagus* (*Nothofagus*) *fusca*; (6) *Beilschmiedia Tawa*; (7) *Pinus Laricio*; (8) *Pinus radiata*.

The first six species are indigenous to New Zealand, the most abundant kinds being *Fagus cliffortioides*, the mountain beech, which usually forms the greater portion of the sub-alpine forests of the South Island, and *Beilschmiedia Tawa*, which covers large areas in the North Island. All the native forms are large trees, except *F. cliffortioides*, which is usually from 20 to 40 ft. in height. The timbers are only of secondary importance, although some of them, such as *F. fusca* and *B. Tawa*, will probably be increasingly used as the more valuable timbers become scarce. *Pinus Laricio* and *P. radiata* are introduced trees, which are being planted on a large scale on Government Plantations throughout the Dominion.

Particulars of the timbers received at the Imperial Institute, and the results of their examination as paper-making materials, are given below. The chemical examination and paper-making trials were carried out on wood freed from bark, and the results refer throughout to the air-dried wood. In the pulping trials each wood was treated with caustic soda under conditions similar to those employed for the preparation of paper pulp on a commercial scale.

(1) *Fagus (Nothofagus) Solandri*

This consisted of three logs of fairly hard white wood, 4 ft. long and 9 in. in diameter, with reddish-brown bark about ¼ in. in thickness.

The wood was submitted to chemical examination with the following results:

	Per cent.
Moisture	13·4
Cellulose	48·5[1]
Ash	0·5

[1] *Equivalent to a yield of* 56·0 *per cent. from the dry wood.*

The ultimate fibres measured from 0·5 to 0·8 mm., being mostly from 0·5 mm. to 0·7 mm. with an average of 0·6 mm.

The results of the paper-making trials are given in the following table:

Trial.	Caustic soda used.		Conditions of boiling.		Parts of caustic soda consumed per 100 parts of wood.	Yield of dry pulp.
	Parts per 100 parts of wood.	Parts per 100 parts of solution.	Time.	Temp.		
			Hrs.	° C.		Per cent.
A	16	4	9	160	11·4	42·5
B	20	4	9	160	12·0	41·5

The pulp produced under the conditions of Trial A was not completely disintegrated and, after bleaching, it yielded a cream-coloured paper which showed many black specks. Under the conditions of Trial B, using 20 per cent. of caustic soda, a satisfactory pulp was obtained which could be bleached almost white; it felted moderately well and produced paper of fair strength.

The results show that this *Fagus (Nothofagus) Solandri* wood gives a fairly good yield of pulp which bleaches almost white and furnishes an opaque paper of satisfactory quality.

(2) *Fagus (Nothofagus) cliffortioides*

This consisted of four logs of white wood, 4 ft. long and 9 in. in diameter, with smooth hard greyish-brown bark about ⅛ in. in thickness.

The wood was submitted to chemical examination with the following results:

	Per cent.
Moisture	15·0
Cellulose	49·0 [1]
Ash	0·4

[1] *Equivalent to a yield of 57·6 per cent. from the dry wood.*

The ultimate fibres measured from 0·5 to 0·85 mm., being mostly from 0·6 to 0·8 mm. with an average of 0·7 mm.

The results of the paper-making trials are given in the following table:

Trial.	Caustic soda used.		Conditions of boiling.		Parts of caustic soda consumed per 100 parts of wood.	Yield of dry pulp.
	Parts per 100 parts of wood.	Parts per 100 parts of solution.	Time.	Temp.		
			Hrs.	°*C.*		*Per cent.*
A	16	4	9	160	10·7	42·5
B	20	4	9	160	13·7	41·5

The pulp produced under the conditions of Trial A was not completely disintegrated, and only bleached to a dark cream colour. The pulp produced under the more drastic conditions of Trial B was readily broken up; it was composed of fibres which felted well, could be bleached white, and yielded a paper of fairly good strength.

The yield of pulp from this wood was equal to that from the sample of *Fagus* (*Nothofagus*) *Solandri*. The pulp is similar in quality to that of the latter wood, but is more readily bleached.

(3) *Fagus* (*Nothofagus*) *Menziesii*

This consisted of four logs, 4 ft. long and 9 in. in diameter, of moderately hard wood of a pale pinkish-white tint. The logs were covered with fairly smooth greyish-brown bark about ⅛ to ¼ in. in thickness.

The wood was submitted to chemical examination with the following results:

	Per cent.
Moisture	13·1
Cellulose	45·1 [1]
Ash	0·5

[1] *Equivalent to a yield of 51·9 per cent. from the dry wood.*

The ultimate fibres measured from 0·5 to 0·95 mm., being mostly from 0·5 to 0·8 mm. with an average of 0·7 mm.

The results of the paper-making trials are given in the following table :

Trial.	Caustic soda used.		Conditions of boiling.		Parts of caustic soda consumed per 100 parts of wood.	Yield of dry pulp.
	Parts per 100 parts of wood.	Parts per 100 parts of solution.	Time.	Temp.		
			Hrs.	°*C.*		*Per cent.*
A	16	4	9	160	11·0	42·5
B	20	4	9	160	13·5	41·5

Trial A yielded a fairly satisfactory pulp which disntegrated almost completely on beating and bleached to ι deep cream tint. In Trial B a paper of very similar haracter was obtained, but the colour after bleaching was onsiderably better.

The yield of pulp from this wood was the same as from he two preceding species of Fagus and the pulp was similar n quality.

(4) *Weinmannia racemosa*

This consisted of three logs of hard reddish-brown wood, neasuring 4 ft. in length and 9 in. in diameter. The vood was covered with fairly hard reddish-brown bark ιbout $\frac{3}{16}$ in. in thickness.

The wood was submitted to chemical examination with he following results :

	Per cent.
Moisture	14·8
Cellulose	41·6 [1]
Ash	0·4

[1] *Equivalent to a yield of 48·8 per cent. from the dry wood.*

The ultimate fibres measured from 0·8 to 1·3 mm., being mostly from 0·9 to 1·1 mm. with an average of 1·0 mm.

The results of the paper-making trials are given in the ollowing table :

Trial.	Caustic soda used.		Conditions of boiling.		Parts of caustic soda consumed per 100 parts of wood.	Yield of dry pulp.
	Parts per 100 parts of wood.	Parts per 100 parts of solution.	Time.	Temp.		
			Hrs.	°*C.*		*Per cent.*
A	16	4	9	160	9·7	40·0
B	20	4	9	160	10·4	36·5

The pulp produced in Trial A was not completely disintegrated. The more drastic conditions of Trial B furnished a satisfactory pulp which bleached readily to a pale cream colour and yielded a fairly strong paper.

The yield of pulp from this wood is rather low, but the pulp bleaches satisfactorily, has good felting properties, and furnishes paper of fairly good strength.

(5) *Fagus (Nothofagus) fusca*

This consisted of four billets of fairly hard wood of pale pinkish-buff colour, measuring 5 ft. in length and from 7 to 14 in. thick.

The wood was submitted to chemical examination with the following results:

	Per cent.
Moisture	12·7
Cellulose	47·9 [1]
Ash	0·3

[1] *Equivalent to a yield of 54·9 per cent. from the dry wood.*

The ultimate fibres measured from 0·9 to 1·7 mm., being mostly from 1·0 to 1·3 mm. with an average of 1·2 mm.

The results of the paper-making trials are given in the following table:

Trial.	Caustic soda used.		Conditions of boiling.		Parts of caustic soda consumed per 100 parts of wood.	Yield of dry pulp.
	Parts per 100 parts of wood.	Parts per 100 parts of solution.	Time.	Temp.		
			Hrs.	*° C.*		*Per cent.*
A	16	4	12	160	9·3	47·5
B	20	4	9	160	13·2	44·0

The pulp obtained under the conditions of Trial A was not completely disintegrated. Trial B gave satisfactory results, the pulp bleaching well and yielding a fairly strong paper.

This wood gives a fairly good yield of pulp, from which paper of satisfactory quality can be made.

(6) *Beilschmiedia Tawa*

This sample consisted of four billets of fairly hard

vood, measuring 5 ft. long and from 7 to 14 in. in hickness, from which the bark had been removed. The vood was white, streaked and mottled with brownish-ɔlack.

The wood was submitted to chemical examination with he following results :

	Per cent.
Moisture	12·6
Cellulose	50·0 [1]
Ash	0·8

[1] *Equivalent to a yield of 57·2 per cent. from the dry wood.*

The ultimate fibres measured from 0·7 to 1·3 mm., ɔeing mostly from 0·9 to 1·2 mm. with an average of ɪ·0 mm.

The results of the paper-making trials are given in the ollowing table :

Trial.	Caustic soda used.		Conditions of boiling.		Parts of caustic soda consumed per 100 parts of wood.	Yield of dry pulp.
	Parts per 100 parts of wood.	Parts per 100 parts of solution.	Time.	Temp.		
			Hrs.	°C.		Per cent.
A	16	4	9	160	8·2	44·0
B	20	4	9	160	9·8	42·5

The pulp obtained in Trial A was not completely lisintegrated. Trial B yielded pulp of better quality, which bleached fairly satisfactorily, felted well, and gave a moderately strong paper.

This wood gives a fairly good yield of pulp and furnishes paper of good quality and fair strength.

(7) *Pinus Laricio*

This sample consisted of seven logs of rather soft white wood, measuring 5 ft. in length and 6 in. in diameter, from which the bark had been removed. The wood contained numerous knots.

The wood was submitted to chemical examination with the following results :

	Per cent.
Moisture	10·4
Cellulose	57·7 [1]
Ash	0·4

Equivalent to a yield of 64·4 per cent. from the dry wood.

The ultimate fibres measured from 2·6 to 4·1 mm., being mostly from 2·9 to 3·8 mm. with an average of 3·4 mm.

The results of the paper-making trials are given in the following table :

Trial.	Caustic soda used.		Conditions of boiling.		Parts of caustic soda consumed per 100 parts of wood.	Yield of dry pulp.
	Parts per 100 parts of wood.	Parts per 100 parts of solution.	Time.	Temp.		
			Hrs.	°*C.*		*Per cent.*
A	20	3	9	160	14·6	45
B	24	4	9	160	15·6	39

This wood proved to be more resistant to the action of caustic soda than any of the six preceding samples, and was not completely disintegrated by treatment with 20 per cent. of caustic soda. Even under the more drastic conditions of Trial B the pulp obtained did not break up very readily. The pulp bleached to a cream colour, and produced a fairly satisfactory paper of very good strength.

The presence of knots in this wood probably accounts for the drastic treatment which was necessary to disintegrate it. The yield of pulp is not very good, and the pulp only bleaches to a cream colour.

(8) *Pinus radiata*

This consisted of three logs of rather soft white wood, from which the bark had been removed, and which measured 5 ft. in length and 10 in. in diameter. The wood contained numerous knots.

The wood was submitted to chemical examination with the following results :

	Per cent.
Moisture	11·2
Cellulose	56·6 [1]
Ash	0·5

[1] *Equivalent to a yield of* 63·7 *per cent. from the dry wood.*

The ultimate fibres measured from 2·0 to 2·8 mm., being mostly from 2·1 to 2·5 mm. with an average of 2·3 mm.

The results of the paper-making trials are given in the following table :

Trial.	Caustic soda used.		Conditions of boiling.		Parts of caustic soda consumed per 100 parts of wood.	Yield of dry pulp.
	Parts per 100 parts of wood.	Parts per 100 parts of solution.	Time.	Temp.		
			Hrs.	° *C.*		*Per cent.*
A	20	3	9	160	10·0	46
B.	24	4	9	160	14·0	39

The results obtained with this wood are somewhat similar to those given by the sample of *Pinus Laricio* wood. The pulp obtained on treatment with 20 per cent. of caustic soda was not completely disintegrated and did not bleach well. On treatment with 24 per cent. of caustic soda a fairly satisfactory pulp was obtained which bleached to a cream colour, had good felting power, and furnished a very strong paper.

As in the case of the *Pinus Laricio* wood, the numerous knots in this material rendered it necessary to employ a high percentage of caustic soda. The pulp produced is similar to that obtained from the *Pinus Laricio* wood both in quality and yield.

General Remarks and Conclusions

The results of the examination of these eight New Zealand woods at the Imperial Institute show that the four species of *Fagus* (*Nothofagus*) yielded pulps of similar character, which bleached readily and furnished fairly strong papers of good quality. The yields of pulp were fairly good (41·5 to 44·0 per cent.), that from *F. fusca* being the best. The *Beilschmiedia Tawa* wood also gave a fairly good yield of pulp (42·5 per cent.) and yielded paper of similar quality to that obtained from the species of *Fagus*.

The *Weinmannia racemosa* wood gave a rather low yield of pulp (36·5 per cent.) which, however, bleached satisfactorily and had good felting properties.

The strongest papers were obtained from the woods of *Pinus Laricio* and *Pinus radiata*, but the pulps from these woods did not bleach quite so readily as those from the other six samples. The yields of pulp were, moreover, only

moderately good (39 per cent.), and owing to the presence of numerous knots in the wood, a larger amount of caustic soda was required than in the case of the other timbers.

All these timbers would be suitable for the manufacture of paper pulp in New Zealand if available in sufficient quantities; but before the manufacture of pulp is undertaken on a commercial scale, a number of factors will need careful consideration. These include:

(1) The quantity of the waste wood which will be regularly available. In this connection, it seems probable from the results of the trials described in this report that the woods of the four species of *Fagus* (*Nothofagus*) and those of *Beilschmiedia Tawa* and *Weinmannia racemosa* might be used in admixture. The woods of *Pinus Laricio* and *P. radiata*, however, require more drastic treatment, and should therefore not be mixed with the others.

(2) The price per ton at which the waste wood could be delivered at the pulping mill.

(3) The selection of a suitable site for the mill. This should be situated in a locality provided with good facilities for transport (by rail or water) and with an ample supply of water.

(4) The cost of erecting and equipping the mill.

(5) The cost of fuel and chemicals (particularly soda and lime), delivered at the mill.

(6) The cost of superintendence and labour.

(7) The value of the pulp in New Zealand and Australia as a substitute for the wood-pulp at present imported.

WEST AFRICAN CORKWOOD

The tree yielding the corkwood of West Africa is *Musanga Smithii*, R. Br., belonging to the Natural Order Moraceæ. It is widely distributed in tropical Africa, and is commonly known as the "umbrella tree." The stems are often 30 ft. high and unbranched, but are sometimes branched, forming a large crown, and in this case the tree may reach a height of 40 ft., with a diameter of 16–20 in. According to one author, trees are occasionally found which are 80 ft. high, with a trunk

5 ft. in diameter. The wood is of extremely low specific gravity, and is used by the natives of the Gold Coast as buoys for fishing nets, and in some parts in the construction of native houses.

Two logs of the wood from Sierra Leone were sent recently to the Imperial Institute for examination. They had been freed from bark, and measured about 5½ ft. in length and approximately 10 in. in diameter. The logs were in dry condition and were badly split, the cracks penetrating to the centre. The sapwood and heartwood were generally of pale yellowish colour and not easily distinguishable, but the heartwood was slightly stronger and closer in texture than the sapwood. The wood weighed 12·8 lb. per cubic foot.

Working Trials

The wood is soft and easily worked, but has a short coarse grain. It cuts readily with a fine-cut saw, and a good surface can be obtained with a small smoothing plane. The wood is not suitable for turning as it splinters and is liable to fracture. Nails are easily driven into the wood, but do not hold well. When glued it gives a good strong joint, as the wood readily absorbs the glue. In varnishing trials it was found that two coats on a well-smoothed surface gave a good finish.

The wood possesses very little strength, and consequently no mechanical tests were made with it.

Trials for Artificial Limbs

The wood is exceptionally light, but owing to its short grain and the difficulty which would be experienced in securing screws or rivets, it did not appear to be very promising for the manufacture of artificial limbs. Specimens of the wood were, however, submitted for trial to manufacturers, who reported that it was unsuitable for their purposes.

This adverse opinion was confirmed by the Artificial Limbs Branch of the Ministry of Pensions, which carried out tests with the wood in comparison with willow, and had a sample arm socket made from a piece of the wood supplied by the Imperial Institute.

2

Paper-making Trials

It seemed probable that this wood could be best utilised for the production of paper pulp, and it was consequently examined from this point of view. The results are summarised below.

The wood as received was found to contain:

	Per cent.
Moisture	8·8
Ash	0·6
Cellulose	51·5
Cellulose, expressed on the dry wood	56·5

The ultimate fibres measured from 0·8 to 1·5 mm., with an average of 1·1 mm.

The wood was treated with caustic soda under conditions similar to those employed in the manufacture of paper pulp on a commercial scale, with the results given in the following table, which are expressed in each case on the wood as received:

Trial.	Caustic soda used.		Conditions of boiling.		Soda consumed per 100 parts of wood.	Yield of dry pulp.
	Parts per 100 parts of wood.	Parts per 100 parts of solution.	Time.	Temp.		
			Hrs.	° C.		*Per cent.*
A	16	2·65	6	160	12·6	50
B	16	2·65	8	160	12·8	50
C	20	3·3	7	160	12·6	50
D	20	3·3	8	160	13·3	44

The wood required rather drastic treatment, but it gave a good yield of pulp which possessed satisfactory felting properties. The pulp obtained in trials A, B and C would not bleach, and that from Trial D only bleached to a cream colour.

The pulp obtained from Trials B and C could be used for the manufacture of wrapping paper, whilst that obtained from Trial D would furnish a soft, strong, pale brown paper of good texture.

The wood was also treated by the sulphite process, and was found to yield 56·25 per cent. of dry pulp, expressed on the wood as received. The pulp was slightly darker than that obtained by the soda process, but when bleached it was almost white. The papers made from the

eached and unbleached pulps obtained by the sulphite ocess were not quite so strong or so soft as those from e pulps prepared by the soda process, but it should be ssible by modification of the sulphite treatment to tain pulp which will furnish a good white paper.

General Remarks

The results of the experiments carried out with this est African corkwood indicate that it could not be ilised for making artificial limbs, but that it might be itable for the manufacture of toys and certain small ticles. It is doubtful, however, whether there would be y special demand for the wood in the United Kingdom the latter purposes.

As a source of paper-pulp, however, the wood is a omising material. It is not likely that it could be ofitably exported for this purpose, but if a pulp mill re established in Sierra Leone, the corkwood could utilised for the manufacture of paper pulp for export.

THE COMMERCIAL UTILISATION OF COTTON STALKS

E question of the most economical method of dising of the enormous quantities of cotton stalks which left after the crop has been harvested is one that has eived much attention. The destruction of the stalks particularly important if they are liable to harbour ect pests, which might otherwise be carried over from season to the next.

It is usual in most cotton-growing countries to use the on stalks as fuel, and their utilisation in any other ction would therefore depend on their local value for purpose.

The bark of cotton stalks contains a fibre of a charr somewhat resembling that of jute. Trials were made years ago in the United States to extract this fibre commercial scale, and a decorticating machine was which was capable of being worked in the cotton thus obviating the transport of the stalks to a mill.

Five tons of the stalks gave one ton of bark, yielding 1,500 lb. of fibre, which was said to be suitable for the manufacture of bagging for cotton bales. The preparation of the fibre did not prove commercially successful, owing to the difficulty of devising a machine which would satisfactorily work up the rough, irregular material.

Experiments have also been made in Egypt on the possibility of utilising cotton stalks as a source of fibre, and small samples of fibre, some long and some short, prepared by a special process, have been examined at the Imperial Institute. It was considered that the longer fibre might possibly be employed as a substitute for the lower grades of Indian jute and, if found suitable for this purpose, would probably realise rather less than half the price of Bengal jute. The shorter fibre might be used for stuffing upholstery or for paper-making.

It seems very unlikely that the extraction of fibre from the bark of the stalks would be profitable, as the work involved in handling and retting the stalks and preparing the fibre would not be repaid by the price obtainable for the product. In this connection it may be roughly estimated that with a yield of 1,000 lb. of stalks per acre, it would be necessary to collect and treat the stalks from 10 acres to obtain ½ ton of fibre, the value of which would be only about half that of Bengal jute.

Trials with cotton stalks as a paper-making material have been made at the Imperial Institute, and also in the United States. The trials carried out by the United States Department of Agriculture showed that the stalks require somewhat severe treatment. The yield of pulp varied from 35 to 43 per cent., and the fibre was said to be short and weak. With this yield of pulp, and the estimated production of stalks of 1,000 lb. per acre, it would need the stalks from at least 5 acres to produce 1 ton of pulp. The pulp was found difficult to bleach on account of its dark outer bark, and the results, on the whole, were not regarded as encouraging. The results of the trials at the Imperial Institute, detailed particulars of which are given in succeeding pages, were, however, more promising. In this connection it is of interest that a satisfactory method of working cotton stalks has now

been devised in the United States, and that in 1917 it was reported that a Company had been formed in Dallas, Texas, to manufacture paper from this material.

Experiments have been made in Egypt on the possibility of employing cotton stalks for the manufacture of charcoal, methyl alcohol, acetate of lime and other products of destructive distillation. Samples of charcoal, methyl alcohol, acetate of lime and tar obtained in these experiments have been examined at the Imperial Institute. The charcoal was of loose texture, unusually high in ash, and of low calorific value. The methyl alcohol and acetate of lime were of good quality, and would be readily saleable. The tar, however, resembled that obtained from hard-wood, and would probably be difficult to dispose of in the United Kingdom.

Preliminary trials have also been made at the Imperial Institute to determine the yield and nature of the products obtainable from the stalks by dry distillation, and the results of these will be found on pages 17–18 of this article.

Paper-making Trials with Cotton Stalks

Cotton stalks from the Punjab and the Central Provinces, India, have been examined recently at the Imperial Institute. Those from the former Province were from 5 ft. to 7 ft. in length and had a diameter at the base of ⅝ in. to ⅞ in. They were fairly hard and woody, were covered with a brown, rather fibrous bark, and had a narrow, pithy core. The stalks from the Central Provinces were similar, but were thinner, varying in diameter from ¼ to ½ in. All the stalks were devoid of leaves.

The stalks were examined with the following results :

	Stalks from the Central Provinces. *Per cent.*	Stalks from the Punjab. *Per cent.*
Moisture	10·2	10·7
Cellulose	44·1 [1]	40·3 [2]
Ash	2·6	3·0

[1] *Equivalent to a yield of* 49·1 *per cent. from the dry material.*
[2] *Equivalent to a yield of* 45·1 *per cent. from the dry material.*

The ultimate fibres measured from 0·5 to 1·0 mm. in the case of stalks from the Central Provinces, and from 0·6 to 1·2 mm. in the case of those from the Punjab, the average in both cases being 0·8 mm.

The stalks were treated with caustic soda under conditions similar to those employed in the manufacture of paper on a commercial scale, with the following results, which are expressed on the material as received :

Stalks from—	Expt.	Caustic soda used.		Conditions of boiling.		Parts of soda consumed per 100 parts of stalks.	Yield of dry pulp.
		Parts per 100 parts of stalks.	Parts per 100 parts of solution.	Time.	Temp.		
				Hours.	° C.		*Per cent.*
Central Provinces	A	16	4	8	160	11·8	41
	B	16	4	10	160	13·0	40
	C	22	5	9	160	14·6	37·5
Punjab	—	22	5	9	160	14·6	34

These results show that the stalks from the Central Provinces, when treated with 16 per cent. of caustic soda, furnished a moderately good yield of pulp, which, however, did not break up completely or bleach very well.

A satisfactory pulp was obtained from the stalks from both the Punjab and Central Provinces by employing 22 per cent. of caustic soda. In each case the pulp bleached to a pale cream colour, and furnished a moderately strong paper of fair quality. The yield of pulp in these trials was, however, rather low.

The stalks from the Central Provinces were also treated by the sulphite process for four hours at a temperature of 140° C., and yielded 40 per cent. of dry pulp, expressed on the dry stalks. The material was readily broken up by comparatively mild treatment, but the pulp produced was very dark and could not be satisfactorily bleached; moreover, it furnished a paper of poor strength and quality. These attempts to produce a satisfactory pulp by the sulphite process were not successful, as the treatment, though mild, was found to weaken, and partially decompose, the wood-fibre of the stalks.

The results of the investigation show that, when treated by the caustic soda process, these Indian cotton stalks yield paper pulp of fair quality, which can be bleached to a pale cream tint. The yield of pulp is rather low, and it is necessary to employ larger quantities of caustic soda than in the case of esparto and similar grasses, but the results are sufficiently promising to justify further consideration.

In connection with the possible utilisation of the stalks for paper-making in India, there are several points which need investigation. One of the most important is the cost of collecting the stalks from the field and conveying them to the factory. On account of the bulky nature of the material, it would be essential for the factory to be situated in a locality where large supplies of the stalks are available at a minimum cost for transport, and it would be necessary to have an ample supply of water and facilities for the transport of the pulp to the paper factory. The cost of the necessary fuel and chemicals would also have to be ascertained. In addition, it would be advisable to have large-scale trials carried out, preferably in India if this could be arranged, in order to determine the results obtainable on treating the stalks on a commercial scale.

Distillation Trials with Cotton Stalks

Preliminary trials have been carried out recently at the Imperial Institute with a view to determining the possibility of utilising cotton stalks for the production of charcoal, pyroligneous acid and other products, by the process of dry distillation. The stalks used came from the Central Provinces, India. The results, expressed in percentages by weight on the stalks as received, are shown in the following table, which also includes for comparison the corresponding figures recorded for wood :

	Present sample of cotton stalks.	"Hard-wood." (1)	"Wood." (2)
Weight of material distilled	3 lb.	—	—
Time required for distillation	3 hrs. 35 min.	—	—
	Per cent.	*Per cent.*	*Per cent.*
Charcoal	35·4	25 to 27	29
Crude pyroligneous acid	41·1	45 to 50	42
Containing:			
Acetic acid	3·0	3 to 4	—
Dissolved tar	2·6	3·5	4
Crude wood naphtha (100 per cent.)	1·5	1·5 to 2 (80 per cent.)	1·25
Tar, separated	7·6	—	6·5
Containing:			
Acetic acid	0·4	—	—
Total yield of tar	10·2	—	10·5
Total yield of acetic acid	3·4	—	3·75

The tar obtained was a fairly thin, readily mobile liquid of brownish-black colour.

The distillation produced inflammable gases (which were burnt as a supplementary fuel under the retort) and yielded a soft charcoal, which broke fairly easily. The charcoal, when ground to powder, did not compare favourably as regards texture and colour with either lamp-black or carbon black, and it would rank only as a fuel charcoal.

The yield of acetic acid is rather below the average quantity obtained from hard-woods, but the yield of wood naphtha is about normal.

The feasibility of distilling cotton stalks successfully in India would depend on finding local markets for the products, particularly the charcoal and tar. There is a large demand in the East for acetic acid, and possibly the wood naphtha would find a market in India. The tar could be employed for creosoting purposes and the charcoal as a fuel.

Regarding the cost of distillation, it may be pointed out that, as cotton stalks are bulky materials, they would require large retorts even if they were cut into pieces and compressed before treatment.

COTTON CULTIVATION IN COLOMBIA

THE production of cotton has been increasing rapidly in Colombia in recent years to meet the demands of the local cotton mills. There are several mills in operation in different parts of the country, and a considerable quantity of yarn is still imported from the United Kingdom, so that it is unlikely that there will be any export of cotton for many years. Reliable statistics of the acreage and yield are not available, but it has been estimated that, in 1917, 19,000 acres were under cotton, and in 1918, 24,000 acres. The production in the former year is estimated at 6,000 bales, of 500 lb., and in the latter year at 5,500 bales, the decrease being attributed to drought. About two-thirds of the output is obtained in the vicinity of Barranquila, and is sold in that town. Most of the remainder is grown

in the Departments of Boyaca and Santander, and is sold in Medellin and Bogota.

According to information recently supplied by Mr. M. T. Dawe, F.L.S., cotton is the principal crop cultivated in the warmer valleys of Boyaca, which lie at altitudes between 3,000 and 4,000 feet above sea-level. It is grown by the peasants in small patches, often in admixture with other crops, such as yuca (cassava), and little if any preparation is given to the soil. Often the land is merely surface cleared, and not ploughed or even hoed. In spite of this, however, the cotton produced is generally of good quality. The seed is separated from the lint by hand in the case of the bulk of the crop. Wooden hand-gins, such as are used in India, are unknown, and only in a single instance did Mr. Dawe see an American saw-gin employed.

The cotton grown in Boyaca appears to be indigenous to the district, and is apparently the same type that was cultivated by the Indians when the Spaniards first visited the region 400 years ago. At that time the natives were engaged in spinning the cotton and in weaving and dyeing cloth by hand, and the same primitive industry is carried on to some extent at the present day, although most of the crop is now purchased by a local mill. The plant cultivated in this region has been identified at Kew as *Gossypium peruvianum*, Cav.

Two kinds of seed-cotton produced in Boyaca have been received at the Imperial Institute from Mr. Dawe, and the results of their examination are given below.

No. 1. "*Boyaca seed-cotton* (algodon mono)."—This cotton was rather harsh, fairly lustrous, clean, and mostly pale brown or khaki, but partly cream-coloured. The yield of lint on ginning was 43·5 per cent. The seeds were dark brown and covered with brown fuzz.

The lint was of good strength, and varied in length from 0·8 to 1·4 in., being mostly from 1·0 to 1·2 in., with an average of 1·1 in.

The cotton was valued in Liverpool at nominally 36*d*. to 38*d*. per lb., with "middling" American at 24·64*d*. per lb.

This cotton was generally of good quality, but had a dark colour and would therefore meet with only a small

demand in the United Kingdom. It would not be advisable to grow this cotton on a large scale for export.

No. 2. "*Boyaca seed-cotton* (white)."—This was moderately harsh, lustrous, clean cotton, varying from cream to pale brown in colour. The yield of lint on ginning was 45 per cent. The seeds were brown, and covered with pale brown fuzz.

The lint was of very good strength, and varied from 0·7 to 1·4 in. in length, being mostly from 1·0 to 1·2 in., with an average of 1·1 in.

The cotton was valued in Liverpool at nominally 50*d.* per lb., with "middling" American (June "futures") at 24·64*d.* per lb.

This cotton was of excellent strength and good quality, and would be readily saleable in this country.

SILK COCOONS FROM NEW SOUTH WALES

ALTHOUGH the mulberry thrives well in parts of New South Wales, sericulture has not hitherto been taken up on an extensive scale, mainly owing to the difficulty of obtaining labour for the work. Silk has been produced experimentally, however, and four samples of cocoons have been examined recently at the Imperial Institute. They were as follows:

No. 1. "*Cocoons from Italian Graine.*"—These cocoons varied in colour, and were evidently of mixed strain. The majority, which were pale buff-yellow, had round ends and a more or less well-defined "waist"; about 3 per cent., however, were white, with no "waist," and a few were of very pale lemon-yellow tint. It would therefore appear either that a pure graine had not been employed, or that sufficient care had not been taken in the cultivation to keep different varieties separate. The cocoons had very little loose silk on the outside, and none of them had been pierced; but about 3 per cent. were stained through to the exterior.

The cocoons varied from 1·0 to 1·8 in. in length and from 0·4 to 0·8 in. in diameter, the average length being 1·5 in. and the average diameter 0·7 in. The

average weight of the cocoons as received was 0·60 gram, and after the removal of the chrysalides 0·29 gram.

No. 2. "White Cocoons from Australian and Japanese Graine."—These cocoons were of mixed character, about 75 per cent. being white with rounded ends, although a few were tapered at one end. About 23 per cent. of the cocoons were similar to those of Sample No. 3 (see below), being greenish and mostly tapered at one end, whilst the remainder were buff-yellow and similar to the majority of the cocoons in Sample No. 1. On the whole the walls of the white cocoons were thinner than those of the other varieties.

The cocoons had only a slight amount of loose silk on the outside, and had not been pierced, but about 4 per cent. were stained on the exterior.

The cocoons varied from 1·0 to 1·6 in. in length, and from 0·3 to 0·8 in. in diameter, the average length being 1·5 in., and the average diameter 0·7 in. The average weight of the cocoons as received was 0·58 gram, and after the removal of the chrysalides, 0·22 gram.

No. 3. "Green Cocoons from Australian and Italian Graine."—About 75 per cent. of the cocoons were pale yellowish-green and of very mixed character, some having rounded ends and showing a " waist " as in the " Italian " kind (No. 1), while others showed no " waist " ; most of the latter type were, however, tapered at one end, and had a moderate coating of loose silk. About 15 per cent. of the cocoons were white or very faintly tinged with green, and most of the remaining 10 per cent. were of the same type as the majority in Sample No. 1, with the characteristic " waist " and pale buff-yellow colour. A few of the cocoons were of a similar type to the following kind (No. 4), i.e. of yellow colour and with tapered ends. Only one cocoon had been pierced, but about 5 per cent. were stained through to the outside.

The cocoons varied from 1·0 to 1·8 in. in length, and from 0·5 to 0·8 in. in diameter, the average length being 1·5 in. and the average diameter 0·6 in. The average weight of the cocoons as received was 0·6 gram, and after the extraction of the chrysalides 0·25 gram.

No. 4. " Yellow Cocoons from original Italian Graine

and always kept Interbreeding."—About 30 per cent. of these cocoons were similar to the majority in Sample No. 1, and about 40 per cent. consisted of rich golden tinted cocoons, with one end tapered, the remainder being of intermediate character. All the cocoons had an outer layer of loose silk. None of them had been pierced, and only about 1 per cent. were stained on the outside.

The cocoons varied from 1·1 to 1·6 in. in length, and from 0·5 to 0·9 in. in diameter, the average length being 1·4 in. and the average diameter 0·6 in. The average weight of the cocoons as received was 0·60 gram, and after the removal of the chrysalides 0·25 gram.

Quality of Cocoons.—The cocoons were inspected by the Imperial Institute Advisory Committee on Silk Production. The following opinion was expressed as to their quality:

No. 1.—These cocoons are on the whole of good quality, but of very mixed colour and variable in size.

No. 2.—These cocoons are of poor quality, and show considerable traces of diseased worms, which had probably suffered from flacherie.

No. 3.—This sample contains a preponderance of cocoons known as "Satine," which are of a soft, fluffy nature and show extra brilliance. Such cocoons are unsatisfactory for reeling purposes, as they do not give a clear thread, and sink in water. The pointed shape characterising some of these cocoons is also a disadvantage.

No. 4.—This also contains a quantity of "Satine" as well as a certain number of cocoons showing pointed ends; the colour is more uniform than that of Sample No. 3. The yield of silk from these cocoons would be small.

Reeling Trials.—The cocoons were forwarded, by arrangement with the Advisory Committee, to Sicily for the purpose of reeling. The results reported by the expert who conducted the trial may be summarised as follows:

No. 1.—This contained 75·69 per cent. of fairly good cocoons, 16·21 per cent. of inferior cocoons and 8·10 per cent. of doubles, and was the best of the four in reeling qualities. It yielded 23·3 per cent. of silk and a quantity of frisons (waste) equivalent to 51·2 per cent. of the weight

of the silk, indicating that considerable improvement could be effected in the quality.

The expert considered that the pale colour of these cocoons indicated either that they were over a year old, or that they had been exposed too much to air and light.

No. 2.—This came next to No. 1 as regards reeling quality, and yielded a white silk similar to that produced from Turkish cocoons, though not so white as pure China or Japan silk. No really good cocoons were present in the sample, which was composed of 96·25 per cent. of inferior cocoons and 3·75 per cent. of doubles. In the process of reeling 17·3 per cent. of silk was obtained, and a quantity of frisons equivalent to nearly 64 per cent. of the weight of the silk.

No. 3.—This consisted of 97·50 per cent. of inferior cocoons and 2·50 per cent. of doubles. The cocoons yielded 18 per cent. of silk and a quantity of frisons equivalent to 44·4 per cent. of the weight of the silk. They had very poor reeling qualities, and the silk was not as white as that of No. 2, but rather of a cream colour.

No. 4.—This consisted of 96·25 per cent. of inferior cocoons and 3·75 per cent. of doubles. It yielded 15·1 per cent. of silk and a quantity of frisons equivalent to 56·7 per cent. of the weight of the silk. The cocoons had very poor reeling qualities, and the colour of the silk was of a faded nature.

For comparison with the results of the reeling trials, the expert stated that the best Calabrian and Sicilian cocoons only yield amounts of frisons equivalent to about 20 and 24 per cent., respectively, of the weight of reeled silk obtained. He regarded all these cocoons from New South Wales as of poor quality, and suggested that the worms had been insufficiently or improperly fed, or possibly that the climate was not suitable for the worms, or that the worms were diseased or too inbred. In his opinion however, Australia should produce very good cocoons, if the climate is not too variable, provided that white mulberry-trees are available for feeding the worms and that the subject is thoroughly understood by those concerned in the industry.

General Remarks.—It will be seen that the report of the

expert who undertook the reeling of these cocoons is not very favourable, but the Imperial Institute Advisory Committee on Silk Production are of opinion that the results are not unpromising in view of the circumstances under which the cocoons were produced. The trials might, therefore, be continued if there appears to be any likelihood that the production of silk cocoons on a commercial scale could be remuneratively undertaken in New South Wales. It would be essential to the success of this enterprise that the persons engaged in the work should have a thorough knowledge of the whole subject, and that satisfactory arrangements should be made for the proper feeding and rearing of the worms and for the subsequent reeling of the silk.

HEERIA BERRIES OF SOUTH AFRICA AS A SOURCE OF OIL

FRUITS of *Heeria paniculosa* from South Africa have recently been examined at the Imperial Institute as a source of oil. The plant is a shrub belonging to the Natural Order Anacardiaceæ and is fairly plentiful in Zululand, where it is known by the native name "Isifuku."

The fruits were flat berries, about $\frac{3}{8}$-in. in length, irregularly ovoid in shape, and covered with a closely adhering black skin, which was wrinkled and shiny.

The flesh, or pericarp, which was rather hard and sticky, enclosed a single seed, the kernel of which was soft and oleaginous. Many of the berries were shrivelled and immature.

Volatile Oil from Pericarp.—The pericarp of the fruits contained a volatile oil, the yield amounting to 5·5 per cent. of the weight of the entire fruits. In this connection it may be mentioned that small quantities of the berries distilled in the laboratory of the Department of Agriculture, Cape Town, yielded from 4·47 to 6·07 per cent. of volatile oil.

The oil obtained at the Imperial Institute was mobile and colourless, and had no pronounced or characteristic

odour. It was found, on examination, to have the following constants :

Specific gravity at 15/15° C.	0·832
Optical rotation, α_D	+ 3·75°
Acid value	1·6
Ester value before acetylation	4·2
Ester value after acetylation	14·8

These results indicate that the oil consists principally of terpenes, and, as it has no distinctive odour, it would be of little commercial value.

Fixed Oil from Kernels.—The crushed fruits, after the removal of the volatile oil by distillation, furnished a quantity of fixed oil from the kernels equivalent to a yield of about 30 per cent. from the entire fruits. The oil was viscous, clear and dark brown, and had an aromatic, not unpleasant odour.

The results of this investigation show that the fruits of *Heeria paniculosa* contain volatile oil in the pericarp and a fixed oil in the kernels, the amounts of these constituents being about 5·5 and 30 per cent. respectively on the weight of the entire fruits. The fruits are not readily separable into pericarp and seed or kernel, and if the fixed oil were extracted from the entire fruits it would be contaminated with the volatile oil, and would consequently be of little or no technical value. In order to remove the volatile oil, it would be necessary to submit the fruits to steam distillation, and the fixed oil could then be obtained from the residue by expression or by extraction with solvents. As already indicated, however, the volatile oil is not likely to be of much value, and the treatment would probably not be remunerative.

It does not appear likely that these fruits of *Heeria paniculosa* would find a ready market as a source of oil, in view of the many superior oil seeds which are available.

GENERAL ARTICLES

THE CULTIVATION OF THE SUGAR-CANE AND MANUFACTURE OF CANE SUGAR

In the following pages a general account is given of the cultivation of the sugar-cane and the methods of manufacturing cane sugar. The world's trade in sugar, with special reference to the Empire, will be dealt with in a separate article.

For the preparation of the ground-work of this article the Imperial Institute is indebted to Mr. A. H. Kirby, Assistant Director of Agriculture, Southern Provinces, Nigeria, and formerly Scientific Assistant, Imperial Department of Agriculture, West Indies, who volunteered during his period of leave in this country during the war to give assistance in the work of the Institute. Mr. G. C. Dudgeon, C.B.E., lately Consulting Agriculturist to the Government of Egypt, has kindly given considerable assistance in revising certain sections.

Cultivation

Climate

Temperature.—Although the sugar-cane is cultivated with success in certain areas in the subtropical belts, as in parts of British India, in Egypt, Madeira, New South Wales and Natal, it attains its best development in the tropics, where the temperature is highest (provided that the other circumstances are favourable); here the canes grow longest and thickest, and reach maturity earliest: in fact the time between planting and flowering (" arrowing ") increases progressively with the distance north or south of the Equator. In latitudes well outside the tropics the growing season is short, owing to the low winter temperature, so that the cane is immature when reaped and yields an impure juice with a low sugar content. In subtropical latitudes nearer the Equator, on the other hand, where the cane is able to survive the cold season, although its growth is affected, the plant yields rich juices possessing a low content of impurities.

Elevation has the same effect on the life processes of

sugar-cane as the lower temperatures existing beyond the limits of the tropical belt. Thus, frosts are as likely to damage the cane in the elevated regions of tropical India, where the plant is grown, as in the extra-tropical sugar-growing region of Louisiana. As regards less severe conditions, the retardation of maturity in the canes grown on the slopes of the hills in India and Java is much the same as in those raised in Mauritius and Hawaii, near the edge of the tropical belt. Varieties of cane differ from one another in their susceptibility to low temperatures: as a general rule, dark-coloured canes bear the colder conditions better than light yellow canes; but all kinds usually flourish well in the humid equatorial regions where the plant finds its proper habitat. In the conditions of the lower temperatures, early maturity is of advantage; this is illustrated by the fact that there are the two or three early-maturing seedling canes produced in Demerara, which have assisted, or are likely to assist, greatly the sugar industry of Louisiana. Where high temperatures appear to interfere with the proper development of sugar-cane, it is usually the want of humidity in the air, or of water in the soil, that actually causes the untoward condition.

Rainfall.—Sugar-cane grows successfully under very different conditions of rainfall: where the precipitation is heavy the plant requires the existence of a dry season to enable it to ripen; where the rainfall is nearer 40 inches a humid atmosphere is necessary for successful sugar production. In Queensland alone, the rainfall for sugar growing varies from less than 50 inches in some places to more than 150 inches in others. It is most important that good rains should be received during the chief period of the vegetative growth of the cane; the lack of rain after this, although it decreases the weight of the crop and therefore the amount of sugar per acre, does not impair the quality of the juice, provided that the canes are cut sufficiently soon. Cane left standing during a long period of drought will, however, show plainly the outward signs of a lack of water, and yield a juice of lessened amount, and of a quality that causes much difficulty in the factory.

The successful cultivation of sugar-cane in dry dis-

tricts is assisted by the introduction and production of drought-resistant varieties. Of much importance, too, in this respect, for the world's production of sugar, is the extent to which irrigation is employed for assisting, or completely furnishing, the water supply of the soil, where the rainfall is comparatively small or entirely wanting, and especially where the humidity of the atmosphere is low. This importance of irrigation for sugar-cane is illustrated by the fact that it is employed for the crop in Egypt, India, Java, Hawaii, Peru and Formosa; and to a smaller extent in Mauritius, and the West Indian islands of Cuba, Jamaica and Porto Rico.

As is shown later, canes grown where the rainfall is heavy and the drainage of the soil poor are not likely to be of any use for sugar production; whilst in such conditions of rainfall, even if the soil is well drained, the juice expressed from the canes possesses a low sugar content.

Wind-belts.—The employment of wind-breaks in sugar-cane cultivation is a matter that has received very little attention; it seems that the provision of such means of protection has only been made on any extensive scale on one or two plantations in the Hawaiian Islands, and in Egypt at the Kom Ombo Estate, where, by planting rows of *Sesbania* sp. or *Cajanus indicus*, the canes have been preserved from being laid by the wind. The adoption of such an expedient would be most useful where the humidity of the atmosphere is low and the soil moisture is reduced through the prevalence of drying winds; and where, as in Mauritius, Fiji and some West Indian islands, the cane is sometimes laid, broken, or the crops even destroyed by cyclonic storms. With reference to humidity, it should be stated that much attention has been given to its influence in cane growing, especially from the fact that many of the chief areas where the crop is raised are situated on islands or in coastal districts; but this circumstance probably arises rather from economic than natural conditions (see p. 30).

Further information is required in regard to several matters relating to the use of wind-belts in sugar-cane growing: notably the greatest distances that they may

be placed apart, under different conditions, while still remaining effective; and the relation between the loss sustained through their occupation of useful cane land and the increased production that may accrue through their employment.

Soil and Situation

Sugar-cane may be grown successfully on soils very different in nature, provided that the rainfall is sufficient and the drainage adequate. The circumstance that sugar is produced from the cane in large quantities in the heavy soils of Demerara, Java, Cuba and Louisiana, in the intermediate soils (clays with sand or sandy soils with clay) of Egypt, in the light soils of Hawaii, and in the calcareous soils of Peru and some West Indian islands, is sufficient to illustrate this. In light soils good rainfall or irrigation is required; in heavy soils the drainage must be efficient, especially where the precipitation is above the normal.

The soils best suited to sugar-cane are well-drained clays; next in order are humus-bearing soils containing a large percentage of loam: such are many alluvial soils. As water generally percolates comparatively slowly through such soils, the condition of the subsoil underlying them is important; this must be permeable in order to afford proper drainage.

Rich soils full of humus yield luxuriant canes with inferior juice. Light, sandy soils are likely to give comparatively small canes with pure juice, possessing a good sugar content; where the rainfall is low, the canes grown in such soils are dry with a high fibre content. Calcareous soils often form a very favourable medium for sugar-cane growing; special stress has been laid on their suitability for the purpose, particularly in regard to the supposed high purity of the juice from canes grown in them. The plant tolerates soils containing what may be regarded as high proportions of common salt: this is seen especially in Demerara, parts of coastal India, the Straits Settlements and Louisiana; but in these circumstances it yields a juice that causes much trouble in the factory. Finally, the soils most inimical to cane growing are heavy clays, badly drained and wetted by much rain.

As regards the situation of areas for sugar growing, this has depended almost as much on economic conditions as on the circumstances of climate. Flat or undulating lands, and the lower slopes of hills have been favoured for the crop, the soils being alluvial or derived from the weathering of volcanic rocks *in situ*, or more rarely calcareous, as in some West Indian islands and Peru. The consistency with which sugar-cane growing for commerce is carried on in insular or coastal areas has led to the opinion in the past that humidity of the air, or its acquirement of salinity from sea-breezes, contributes of itself in an important way to the successful development of the plant ; but, as has been indicated already, the choice of such areas has doubtless been guided by considerations of the facility of trading and of transport rather than the natural conditions.

The use of hill slopes for sugar-cane depends mainly on questions of transport, methods of cultivation, soil-wash and the provision of irrigation where this is needed. Methods of cultivation, especially, require modification : on the steeper slopes cultivation by hand must largely, if not completely, take the place of tillage by means of machinery. The loss of soil by washing may be largely reduced by making the cultivation, with its ridges and furrows, follow the contour lines of the hills. The provision of irrigation in situations such as those under consideration, as well as on the flat, has received much attention in the Hawaiian Islands ; and the matter is of present practical interest chiefly in Mauritius among British sugar-growing countries.

Varieties of Sugar-cane

It is usual to regard all kinds of the cultivated sugar-cane as belonging to one species (*Saccharum officinarum*) ; much confusion has existed, however, in regard to the identity and interrelationships of the different varieties. The complexity of the subject does not admit of its adequate treatment in this place : it is best studied in the writings of Harrison and Jenman in Demerara, Fawcett and Cousins in Jamaica, Barber in India,

Soltwedel in Java, Stubbs in Louisiana, and Deerr and Eckart in Hawaii; the former of the two last-mentioned investigators has given a useful short general summary of the matter in his text-book on sugar-cane and cane sugar (*Cane Sugar*, 1911, pp. 23–44).

Among the standard and best-known canes are the Cheribon, Otaheite, Tanna, Salangore, Cavangerie, Uba and Tip Canes. The different varieties under Cheribon have been classified as belonging to three main kinds: the light-coloured, dark-coloured and striped varieties; to the first of these belong chiefly White Transparent, Mont Blanc, Rappoh, Naga B, Light Java, Crystallina, Burke and White Cheribon; to the second mainly Purple Transparent, Purple Mauritius, Queensland Creole and Black Cheribon; to the third Transparent, Red Ribbon, Mauritius Ribbon, Striped Louisiana and Striped Cheribon. Under Otaheite the chief are those called Bourbon (an old variety once much prized in the West Indies), Lahaina, the Otaheite of Java and Cuba, Louzier, Portii and Cuban; whilst Keni-keni is also included in this group by some authorities.

The third-mentioned standard variety, Tanna, has been cultivated in Mauritius in three different forms: the Striped, White Tanna and Black Tanna; the most widely grown of these has been White Tanna, identified by Deerr with Yellow Caledonia. Salangore, which is also known by various names in different places, is not of much economic importance: it has been long recognised as a definite variety, and it appears in Demerara under the names Green Transparent and White Mauritius. Cavangerie is synonymous with Po-a-ole, Port Mackay (of Mauritius) and Altamattie. Mention should also be made of the Bamboo Canes, a name given to several varieties which are neither synonymous nor allied.

The Cheribon canes are fibrous, and their quality of early maturity makes them suited for growing in the sugar-producing countries possessing a cooler climate. Otaheite canes, like the Cheribon, are large contributors to the total production of cane sugar, but are less hardy, and are particularly suited to the hottest climates; under favourable conditions they give a high yield and a pure juice, but are

somewhat liable to loss through attacks by disease. The Tanna varieties, on the other hand, are much less likely to be affected in this way: their hardness protects them from both fungi and insects; they are deeper-rooted than the Otaheite, and thus withstand drought better. Salangore gives very uncertain results under varying conditions; whilst Cavangerie is suited to circumstances in which richness and purity of juice are less important than the ability to yield profitably in the cooler regions within the tropics. Uba canes have proved particularly useful in countries outside the tropics, such as Natal and Madeira. The Tip canes are grown in areas well above sea-level in Hawaii.

In the above general account only the better-known varieties are mentioned. For the others, and for those canes of countries such as New Guinea, Java, Hawaii, Brazil and the Pacific Islands, which have received special description, the works dealing especially with the subject should be consulted.

In nature the varieties that arise are usually sports, taking their origin through bud variation. The varieties that have been produced under more or less control, on the other hand, usually come from seed. The production of varieties of the latter kind has received much arduous attention from sugar experimentalists in different parts of the world, especially in Demerara, Barbados and Java; the names of Harrison in Demerara, Bovell in Barbados, and Soltwedel in Java, are the chief to be connected with the classic beginnings of this work. For obtaining seedling canes more than one method is employed: selecting the mature flowering tops (" arrows ") of canes that are likely to yield seed; growing canes of different kinds near together; removing the almost-ripe flowers from one cane and enclosing them in a bag with the unremoved flowers of a cane of another kind; or actually pollinating individual flowers on the plant with pollen from another kind (Lewton-Brain). The first two are the most practical and usual methods. In any case, after there has been time for the formation of seed, the arrows are cut up and sown in boxes of soil sterilised by heat and covered with glass plates or gauze to keep out other small seeds carried by the wind. Later, the cane seedlings which

appear are potted separately and grown in a nursery to obtain the mature plants for examination. Only a few of the seedlings obtained are found worthy of further trial, and the rest are rejected. The quantities of seedlings ultimately produced are such that they have to be designated by numbers, preceded by the initial letter of the name of the country from which they come (except in the case of New Guinea, where the letters N.G. designate naturally-occurring varieties) ; thus, D.95 from Demerara, B.208 from Barbados, J.105 from Java.

Clearing and Laying out the Land

The clearing of new land for plantations is carried out in the manner usually adopted in the tropics. Large trees, where present, are felled, and removed by burning ; this should be followed at the first opportunity by the planting of cover crops to protect the soil and prevent washing. The complete removal of the stumps from such land is necessary in the first stage, and cannot be deferred or executed gradually, as in the case of permanent crops like rubber, cocoa and coffee, if the cultivation of sugar-cane is to be entered upon early. The work, too, has to be thorough, in order that there may be no interference with the cultivation that the crop requires. Under modern conditions the work of stumping and clearing is assisted by the employment of root-jacks and of dynamite for the uprooting of the stumps, and by the use of mechanical tractors for removing heavy stumps and timber, and large stones.

The laying out of the plantation is a matter that depends entirely, for the scheme adopted, on the practice obtaining in the country in which it is situated, on the system of drainage and of irrigation (where this is provided) that is to be employed, on the configuration of the land, and on the means of transport for the canes and manure. The methods employed vary from the complicated system in use in Demerara, before the planting of the cane in rows with the so-called " bank " and " drill " between can be carried out, to the simpler preliminary preparation for the making of rows of " cane-holes " seen in the West

Indies and Mauritius. They are so diverse that they do not lend themselves to general description.

Preparation of the Land

Both when new land is being taken in and when cane is being planted or replanted on a site already cultivated a thorough preliminary tillage of the soil is necessary for the best results. Like the laying out of the plantation and the subsequent cultivation of the cane, the methods employed depend on the kind of husbandry that is practised. In Cuba, new land was (and is still, to some extent), after being roughly cleared by felling and burning, planted with cane in holes simply and irregularly made with the hoe, ox-ploughs being used in later seasons, when the stumps in the land had decayed. In Louisiana and Mauritius, land to be replanted with cane is well manured with green dressings that have been grown on it, cultivation being done mostly with the plough in the former country and with the hoe in the latter. In Java, when the time comes for sugar-cane to be planted in the fields that have been used for rice, the soil has to be dried by digging it out, so as to form trenches about four or five feet apart, and leaving the trenches and the heaps of soil to dry in the sun for a few weeks. In parts of the West Indies, in Cuba and Hawaii, and in some other countries where sugar production is carried out by means of large central factories, steam ploughs are used for the preliminary cultivation, balanced ploughs drawn by cables between two engines being the kind most commonly used.

For the planting of the cane, either furrows and ridges, or holes are made: the furrows and ridges are in commonest use where mechanical tillage is employed; when, as in the British West Indies, Mauritius and Cuba, manual labour or animal labour with simple implements is mostly or largely the means by which cultivation is carried out, holes about eighteen inches square and nearly or quite a foot deep are prepared for the planting. The ridge and furrow planting is most particularly suited for irrigated plantations, as well as for land tilled by machinery, as has already been indicated. Whichever kind of preparation is adopted, it is so effected that the rows of cane are

at least three and rarely more than eight feet apart, the distance being dependent on the richness of the soil, the larger distances being employed in the most fertile soils. In planting in holes, these are usually about two feet apart. A field with 18-inch holes, two feet apart, in rows three feet apart, would have 2,765 holes to the acre; in Mauritius 3,000 holes are reckoned to the acre. In order to obtain a regular stand of cane, lining out is necessary, except where mechanical implements are used, which enable parallel furrows to be made.

Planting

The stem of the sugar-cane is used for propagation in the field, the length to be employed being decided most generally by the kind of planting, whether in holes or furrows; in the latter either long pieces or cuttings may be planted. The commonest plan is to use the tops of the cane; there is little sugar in these, and their condition of vegetative activity helps to ensure sprouting. In Egypt and some other countries, cane tops are not generally used; in Egypt, lengths having three or four joints or nodes, and in Cuba whole canes, are laid in the furrows, double rows being used in the former country to ensure a proper stand. When tops or cuttings are being employed, from one to four, the number depending on the state of the cane, are put into each hole or into each two-foot length of trench. In some islands of the British West Indies, and in Cuba, a simple method of planting consists in driving a hole in the soil by means of a crowbar and pushing the cane top or cutting into the hole, its upper end being then closed with soil by a movement of the foot. Where the soil is heavy, with much clay, the planting material is often buried in the tops of the ridges instead of the bottoms of the furrows. In Demerara, after the soil between the "banks" has been well worked with the shovel, the pieces of cane are planted in a sloping position. The soil covering the tops, cuttings or canes is not usually more than four inches in thickness; but the material is covered more deeply when the rainfall is small.

The provision of material for planting is usually simplified by the circumstance that this is collected during the

time of harvest. Where, however, the fields are all cleared of cane before the land is prepared for the next sugar crop, or where there is a winter season during which the plant will not live in the fields, special means for preserving live cuttings are necessary. Thus, in Bengal and Madras the cuttings are kept in clamps, in which they sprout, while the land is being made ready; and in Louisiana the planting material is windrowed or preserved in "matelas" during the winter. The former circumstance affords one of the few instances where sprouted canes are planted; another is seen in the use in Hawaii of sprouted tops ("lalas") of canes that have stood for some time in the fields after they have flowered ("arrowed").

Nurseries are not very commonly employed in sugar-cane cultivation. Their use is specialised generally for the production of planting material of particular varieties, or for raising seedlings, or for obtaining strong plants from cuttings that have already sprouted. The first of these uses is seen on a large scale in Java, where the nurseries are often made on the higher hill slopes, for the obtaining of material free from the sereh disease (see p. 51). The last is illustrated in the temporary planting in nurseries of canes sprouted in clamps (see above). The other chief use of nurseries, for the raising of seedling canes (first proved possible in Barbados, and rediscovered later for practical use in Java and Barbados) is of much importance in the production of new and specially useful types. The method of raising the seedlings has already been described (p. 32).

Planting material should be selected from the best canes, all those showing discolorations or the attack of boring insects being rejected. It has been shown by experiment, especially in the British West Indies and Java, that continual planting of the heaviest and strongest-growing canes definitely results in the production of larger proportions of rich canes.

Ratooning

Where it is intended to allow the root-stocks left in the ground when the cane is harvested to remain and give rise to a succeeding crop, or ratoons, without replanting, the

preparation of the land for this crop is of necessity simpler than that described above for plant (or first crop) canes. It consists of loosening the soil in the row, weeds being removed at the same time, often after the stumps showing the position of the " stools " or clumps of cane have been cut off flush with the surface of the soil or a short distance below it. A deeper cultivation, whether manual or by machinery, should be made as closely as possible to the rows ; this can be carried out without injury, as the new canes (ratoons) will grow from the root-stocks formed by the last crop (*West Indian Bulletin*, vol. x, p. 117) ; it must be done early, however. At this time an application of artificial manure may be made ; and in dry conditions the trash, or dead leaves from the last crop of cane, may be used as a light mulch for the rows. The response of ratoons to artificial manures is generally more definite than in the case of plant canes.

The number of crops of ratoons raised after one planting varies in different countries ; it does not usually exceed two or three, but on newly cultivated soil in countries such as Cuba, it has been many more than this. Jamaica forms an instance of a country where continuous ratooning has been employed : that is to say, the crop is ratooned year after year, dead plants being replaced in order to preserve the stand of cane ; it is evident that rotation is not possible in such a system. The yield of sugar is less from first ratoons than from plant canes, and from second than from first ratoons, and so on ; but the progressive decrease is least in newly cultivated soils. Where ratoons are grown alone for two or three crops before entirely replanting, the number of times of profitable ratooning is chiefly a matter of the balance of the decreased return against the saving arising from avoiding replanting, although the danger of serious loss from pests, increased in numbers through the continuous presence of cane on the land, must also be taken into consideration.

After-cultivation

This is concerned mainly with weeding, the keeping of the soil in the rows open, moulding up the young canes

while they are becoming established, and cultivating the soil between the rows (" the middles ") ; it is usually at the first stage of this work that manures are applied directly to the crop, apart from any that the soil may have received during the preparation of the land for planting. Where modern methods of tillage are employed this cultivation is carried out as far as possible with mechanical implements, the work being, broadly speaking, of two kinds : (1) drawing away the soil from the rows and throwing it back into them—a process by which the soil is well stirred and the canes moulded up ; and (2) cultivating thoroughly the soil between the rows—" breaking " or " bursting the middles," as it is called. The use of the hoe is necessary for the proper completion of the work in the rows ; on irrigated land there is decreased scope for mechanical implements, and the hoe forms the chief instrument of tillage. The kind and degree of cultivation given after the canes have made a strong stand depend on the rainfall and the cleanness of the land. Sometimes the weeds are kept down and the soil protected by sowing a leguminous crop between the rows.

The after-cultivation of ratoons is similar to that of plant canes ; it includes the weeding, cultivation of the soil in the rows and the moulding up that have been mentioned already. Very thorough cultivation between the rows is necessary, particularly in view of the beating that the soil has undergone during the harvesting of the crop. Thus, in Demerara importance is attached to the proper forking of the banks after harvesting ; and in Cuba a system is recommended in which the middles are ploughed thoroughly with a mould-board plough.

Various schemes are employed or recommended for making use of the trash, or dead leaves removed when the cane is cut and at intervals during its growth (" trashing ") ; in some countries, however, as in Demerara, it is burnt off the canes just before they are cut. The incorporation of this vegetable matter with the soil is of the greatest importance in maintaining its humus content ; and burning, whilst it doubtless directly decreases the number of pests, adds readily available mineral matter to the soil, and saves some expense, at the same time destroys a useful source

of humus and nitrogen and kills parasites that aid in the natural control of insect enemies of the cane.

Implements for Sugar-cane Tillage

As with other crops, the use of the more complicated mechanical implements for tillage is increasing in extent; although the conditions of cultivation make the simple manual implements, the cutlass ("machete"), hoe, fork or spade, the chief instruments of tillage in some countries, such as Demerara, Mauritius, Egypt and the irrigated districts of Hawaii. These tools are needed, too, for finishing the work after the mechanical implements have been used. The latter vary in complexity from the primitive ox-plough of countries like India and Egypt to the modern gang-ploughs and disc-cultivators. For descriptions of all these, agricultural works, especially those dealing with the sugar-cane, as well as makers' catalogues, should be consulted. It is sufficient here merely to give a list of the implements by means of which the different kinds of tillage are carried out:

General preparation of the land: hoe, fork, mould-board plough, gang-plough (worked by steam), disc-plough (in very heavy soils), harrow, disc-harrow.

Making holes: hoe, fork, shovel, single plough.

Making furrows and ridges: hoe, single plough, double mould-board plough, disc-plough.

Weeding and moulding rows: cutlass (weeding only), hoe, light disc-cultivators with wheels and discs running on either side of the row.

Cultivating between the rows (the "middles"), and burying weeds, green dressings or cane-trash: cutlass and hoe, hoe, fork, mould-board plough, disc-plough, cultivator (chiefly breaks up the soil), harrow (stirs the surface of the soil and buries very young weeds).

Much ingenuity has been expended in devising implements for special purposes, and those which will carry out singly or at once several tillage operations; and these are in extended use in modern sugar cultivation.

Drainage

Provision should be made for drainage when the land is laid out and prepared for ploughing; in some cases, how-

ever, a furrow, trench or " drill " is made midway between the rows after the canes are established, and this may be deepened later. In the less heavy soils, especially, the drains need to be kept clear; and in the complex system necessitated in Demerara, constant attention is required for the removal of drainage water by pumping or by arranging for it to run away when the tide is low.

Manuring

Much attention has been given, in different parts of the world, to the manurial requirements of the sugar-cane. Experiments carried out a few years ago at the Station Agronomique, Mauritius, appear to show that under the conditions obtaining there applications of " complete " manures are beneficial. The conditions of sugar-cane cultivation in Java have been shown to call for nitrogenous manures that can be used by the cane immediately, or soon after they have been applied. In Hawaii it has also been demonstrated that nitrogenous manures are the most necessary, whilst decision as to the use and quantities of phosphates and potash requires care and a knowledge of the constitution and properties of the particular soil. The manurial requirements of the sugar-cane in any given case are decided by the circumstances of the soil, rainfall and the husbandry employed; and it is not possible to give any statement of detail that is universally applicable. Each set of conditions requires special examination; and for this purpose experiments conducted on plantations where the cane is grown form the most useful adjunct to the manurial investigations carried out at stations where agricultural enquiry is being made under scientific control.

Besides the kinds of manures already mentioned (nitrogenous manures, phosphates and potash), lime has a general importance in agriculture, as is well known; in the case of sugar-cane, however, its direct importance to the plant is small in comparison with its action on the soil in lightening it, removing acidity, liberating potash and possibly ameliorating the conditions where the proportion of magnesium to calcium is high. Among the by-products of tropical agriculture that are used for manuring the

sugar-cane are various oil cakes and meals, such as cotton-seed meal (Louisiana, West Indies), kapok meal (Java) and castor-seed cake, and waste from fibre extraction and from indigo making. More important are the by-products and refuse from sugar manufacture itself, among these being molasses (subsidiary to its use in export and for rum making), megass (mostly employed as fuel, however), megass ashes (supplying phosphates and potash), filter press cake (containing useful quantities of nitrogen and phosphates, and varying amounts of lime compounds), and the lees or dunder from rum making. Trash and cane-tops are by-products of the cultivation. In Egypt the trash is burnt and the ashes used as a manure; pen manure is also applied—wherever possible—at the time of making the furrows, and when the last cultivation is given; another source of manure is found in the sites of old villages.

Molasses may be applied directly, or in some cases reaches the soil in the irrigation water, and trial has been made of using the lees in the latter way; in the West Indies the lees are allowed to concentrate in a " lees pond " or pit before application, and in Mauritius they are poured over the manure heaps.

It is most usual for some of these products to be employed indirectly for manuring the sugar-cane; for instance, cotton-seed cake and molasses are fed to animals which supply manure for the plantation, the return to the soil being assisted by the use of cane-trash for the litter and unwanted tops for feeding. The plentiful supplies of yeast produced in the manufacture of alcohol might also be employed for feeding draught animals. As in other kinds of husbandry, the inclusion of animals in the system is of the greatest usefulness in cane cultivation; but the modern increase in mechanical means for field work and manufacture tends to bring about an enhanced dependence on artificial manures.

Material for green manures may be raised on the land after the last crop, whatever this may be, has been taken off, or it may be grown between the rows of canes; in the first case it may occupy a place in a definite scheme of rotation. Nearly all the green manure crops commonly

used in the tropics enter into sugar-cane cultivation. They are naturally mostly leguminous; among those that are not, the castor-oil plant has attained importance in British Guiana. Mauritius, Barbados and Louisiana are examples of countries where the use of green manures is of leading importance in the cultivation of the sugar cane: in Mauritius the Lima or Rangoon bean (*Phaseolus lunatus*), the pigeon pea (*Cajanus indicus*), the velvet bean (*Stizolobium deeringianum*) and wild indigo (*Tephrosia candida*) are the principal green manures; in Barbados cow-peas (*Vigna Catjang*), and the pigeon-pea are very largely grown; and in Louisiana the cow-pea is in chief evidence. The growing of such leguminous crops not only adds to the amount of nitrogen in the soil and increases the possibilities of rotation, but protects the land and cleans it of cane pests, and assists in making use of the plant food in the subsoil.

Closely related to manuring is rotation of crops, which has also for its chief object the maintenance of the fertility of the soil. Owing to the particular circumstances of sugar-cane growing, in all the chief countries where it is carried on, with the exception of British India, Egypt and Java, no rotation, or only an interplanting with leguminous crops, is practised, examples of the former being generally afforded in Demerara, part of the British West Indies, Fiji, Hawaii and Cuba, and of the latter in Mauritius, Barbados and Louisiana. Rotation has not only the advantage of cleaning the land and of making thorough use of the different layers of soil, but, where it is practised in the complete sense, it tends to ensure economic stability by lessening the seriousness of the failure of one crop.

Irrigation

The modern tendency for the production of sugar in a few large factories fed by extensive areas of cane is increasing the already great importance of irrigation for this crop, as under these conditions there is a special need that the crop should not vary largely from year to year through the exigencies of rainfall. British India, Egypt, the Hawaiian Islands (except Hawaii itself), Java, the Argentine Republic, and the dry coastal slopes of Peru, as well as

Mauritius, Jamaica, Cuba, the Deccan and Formosa to an increasing extent, all raise sugar-cane by irrigation.

Both surface and underground waters are used for the purpose; among British possessions, Mauritius employs the former and Jamaica mostly the latter. A feature of the irrigation in some of the Hawaiian Islands is the very large reservoirs that are used for storing the water; there, the amount of water given to the land in the seventeen months of the crop, through rainfall and irrigation together, is equivalent in quantity to a precipitation of about 120 inches. Irrigation in Java is very definitely controlled by the State; the water is wanted chiefly for the rice crop, the supply to the cane being made mainly for the purpose of enabling the plant to withstand drought. In Egypt the cane is watered immediately after planting, and again every 20 to 25 days afterwards until it begins to ripen, when the water is entirely withheld; some of this irrigation water, like that of Java, contains silt which possesses important manurial value.

The most common method of allowing the irrigation water to spread over the land is by the use of channels carrying the flow into the furrows in which the cane has been planted; in hole planting, as in Mauritius, the successive filling of the holes as the water passes along causes a large quantity to be needed. The most economical method (considering the consumption of water) is to use furrows fed on both sides of each channel. It is reckoned in Hawaii that the total weight of water (from rainfall and irrigation) wanted for a crop is about 1,000 times as great as the weight of sugar formed.

Harvesting

The mature cane is cut by hand, gangs of field labourers used to the work being employed to sever the canes and the tops with the cutlass or machete. Attempts have been made to lighten the labour by the aid of circular saws and knives and of oscillating knives. These may be operated by compressed air or electricity, or the circular saws and knives may be carried on a machine like the wheat harvester. Still another means has been tried in the form of an endless cutting chain revolving between two traction

engines which at once give it its motion and carry it across the field. Weak features of the heavy machines have been that they failed in fields where the wind or storms had " laid " the cane or made its growth irregular, and that they did not strip the canes of their trash. Most of the devising and experimenting with such machines has been made in Louisiana, where one of the chief inventors, named Luce, is stated to have perfected a cane harvester, which is claimed to be of practical value in cutting, trashing and topping the canes.

It has been shown that cane, after it is cut, will lose as much as nearly 3 per cent. of its recoverable sugar if it is left lying only for one day, whilst in two days it will lose as much as 8 per cent., and in four days nearly one-third of its recoverable sugar. The loss takes place partly through drying and partly through the formation of an inverting ferment, chiefly in the top, which passes through the stem and reduces the quantity of crystallisable sugar. Although these losses may thus be reduced by the topping that the cane usually receives, and by keeping it in wet heaps, it is important that it should reach the factory as soon as possible after it has been cut.

The cut cane is conveyed mainly on light railways or tramways, and in some countries, such as Mauritius, the ordinary railways are used ; traction along roads is chiefly found in old sugar-growing countries where small plantations still exist, as in the West Indies, or where the roads are used to bring part of the cane to the railway. Animal power is mostly used on roads and tramways, although steam traction is the more economical on the former. Animals (mules) are especially useful for the transport of cane and manures on portable tramways on the smaller plantations, and for similar transport to loading places. It is usual now for large factories to collect their cane by means of their own permanent narrow-gauge railways carrying light rolling stock.

Among the more special means of sugar-cane transport are the flat punts of Demerara, hauled on the plantation canals by mules, and the wooden V-shaped aqueducts or " flumes " of Hawaii. The use of aerial ropeways has had no general application for the transport of sugar-cane;

these are employed, however, in Mauritius, and to a much smaller extent in Jamaica.

Under modern conditions mechanical unloaders are used at the factory instead of the very slow means provided by manual labour. Their manner of action depends on whether the cane is hoisted, pulled, tipped or raked out of the wagons; and they deliver it either directly on to a travelling platform which carries it to the mill, or into a hopper leading to the platform.

Pests and Diseases

Insect Pests.[1]—Among the insects which feed externally on the sugar-cane the chief are the sucking insects, comprising mainly scale insects (coccids), froghoppers, the cane fly, the leaf hopper, and plant lice (*Aphis* spp.); these include the insects chiefly responsible for the epidemics of insect pests on the sugar-cane that have taken place. Much less serious among the external insect feeders are the biting insects, including the mole crickets, white ants and thrips, and the caterpillars (of both butterflies and moths) that eat the leaves. The internal feeders include boring caterpillars and the larvæ of boring beetles. The table on pp. 46–47 gives information concerning the more commonly known insect pests of the sugar-cane, a general means of control being indicated where this exists.

A few insects attack the buds or "eyes" of the cane, among these being the larvæ of small forms related to the butterflies and moths (the bud-worms of Hawaii), and a beetle (*Holanaria picescens*) injuring planting material in Java. As is indicated above, leaf-eating caterpillars are of little account in respect of their injury to sugar-cane, as compared with their importance as pests of other crops such as cotton, cereals and some few leguminous plants; they appear to attack cane mainly when their natural control has become less rigid or when their food supply is short. Among boring beetles much attention has been

[1] Useful general and particular information concerning sugar-cane pests s to be found in *Insect Pests of the Lesser Antilles*, Ballou, 1912, various articles in the *West Indian Bulletin*, and *Cane Sugar*, Deerr, 1911, pp. 127–158, all of which have been consulted largely in compiling the present account.

Common Name.	Scientific Name.	Distribution.
EXTERNAL FEEDERS		
Sucking Insects :		
Scale insects and mealy bugs . . .	*Coccideæ*	West Indies, Mauritius, Louisiana
Plant lice . . .	*Aphis* spp., etc.	General
Froghopper . . .	*Tomaspis* spp.	Trinidad
Cane fly . . .	*Delphax saccharivora*	
Leaf hopper . .	*Perkinsiella saccharicida*	Hawaii
Biting Insects :		
Mole crickets . .	*Scapteriscus didactylus*	West Indies and Hawaii
,, ,, . .	*Gryllotalpa africana*	,, ,, ,,
White ants . . .	*Termes* spp.	India, West Indies
Thrips	—	General
Leaf-eating caterpillars	—	,,
Grasshopper . .	*Schistocerca pallens*	West Indies
INTERNAL FEEDERS		
Boring Beetles :		
Root borer . . .	*Diaprepes abbreviatus*	West Indies
Beetle borer . .	*Ligyrus rugiceps*	Louisiana
Cane grub . . .	*Lepidoderma albohirta*	Australia
Walawan beetle . .	*Apogonia destructor*	Java
—	*Anomala orientalis*	Hawaii
Weevil borer . .	*Sphenophorus obscurus*	Pacific countries
,, ,, . .	,, *sericeus*	West Indies
Shot-hole borer . .	*Xyleborus perforans*	,, ,,
Leaf miners . .	—	General
Boring caterpillars :		
Small moth borer. .	*Diatraea saccharalis*	West Indies
Large moth borer. .	*Castnia licus*	British Guiana and Trinidad
Gold fringed borer .	*Chilo auricilia*	India
Pink borer . . .	*Nonagria uniformis*	,,
Green borer . .	*Anerastia ablutella*	,,
Grey stem borer . .	*Diatraea striatalis*	Australia and Java
Purple borer . .	*Sesamia monagrioides*	Africa and Pacific countries
Egyptian sugar-cane borer . . .	,, *cretica*	Egypt
Leucania borer . .	*Leucania loreyi*	,,
Lesser Egyptian sugar-cane borer . .	*Chilo simplex*	,,
White and spotted borers	*Scircophaga* sp.	India
White borer . .	,, *intacta*	Java
Yellow borer . .	*Chilo infurcatellus*	,,
Grey borer . . .	*Grapholitha schistaceana*	,,
Moth borer . . .	*Polyocha saccharella*	India

Part attacked.	Preventive and Remedial Measures.
Aerial shoots	Use of clean cuttings for planting; spraying with mixtures containing kerosene or lime and sulphur, if necessary.
" "	
" "	Special means.
" "	
" "	
" "	Destruction of haunts; laying of baits.
" "	
" "	Cleaning the land by growing cotton or other crops.
" "	Paris green and lime for limited outbreaks of caterpillars on young canes; rarely cause serious damage.
" "	
" "	Poison baits.
Roots (by larvæ)	Good cultivation; rotation of crops; flooding of land; destruction of dead and rotten cane refuse; early removal and burning of stumps before replanting.
" "	
" "	
" "	
Roots and stalk bases	
Stems (by larvæ)	Planting clean material; early removal and burning of stumps before replanting; early moulding of stumps left for ratoons; growing the harder kinds of canes.
" "	
Stems	Fungi should be kept under control, as abundance is correlated with much fungus attack.
Leaves	Special measures seldom necessary, as little damage is usually done.
Stems	Planting clean material; rotation of crops; collection, with encouragement of parasites; growing hard canes; trap-lights for night-flying forms; cutting out dead shoots, in some cases.
"	
"	
"	
"	
"	
"	
"	
"	
"	
Main bud or "heart"	
" "	
" "	
" "	
Roots	

given in the past to the shot-hole borer (*Xyleborus perforans*), especially in the West Indies in relation to its possibly providing places for attack by rind diseases; it is probable that the insect rarely damages sound cane.

Some of the usual methods of control of insect pests, such as the destruction of biting and of sucking insects respectively by poisonous powders or sprays and by poisonous washes, of night-flying insects with trap lamps, the use of bait, rotation of crops and the employment of repellents, are not much employed in the case of the sugar-cane. The chief means of reducing the damage from these pests that have been used so far are (1) the collection of the insects (including the " cutting out of dead hearts " practised in the West Indies) and of the eggs when these are laid on the leaves; (2) the employment of means to encourage the increase of natural parasites; and (3) the selection of clean, uninfested material for planting. The cheaper labour provided by children is especially useful for the work of collection, as has been shown (among other instances) in the control of the chief stem and root borers in the British West Indies; parasitisation is encouraged by the keeping of collected material (generally eggs or larvæ) containing the parasites, in the case, for instance, of those of the " cane fly " and the stem borer of the West Indies, and probably by the avoidance of trash burning. The occurrence in nature of fungoid diseases which attack certain insect pests, a notable example of which is *Isaria Barberi*, which attacks and kills the caterpillar of the West Indian moth borer, suggests a further means of controlling such pests; the most remarkable instance of the employment of such means in practice is the artificial production, on a large scale, of the green muscardine fungus for sowing in froghopper-infested sugar-cane fields in Trinidad.

The flooding of cane fields in Demerara is considered to be useful in reducing the number of insect pests. A similar result is supposed by some to accrue from burning trash and dead cane, which harbour insects; but it may be that the effect is only temporary, because of the destruction (already indicated) of the insect parasites that it entails. The most striking illustration of the recognised usefulness of such parasites has been afforded by their purposeful

introduction into places where they do not already exist: particularly in Hawaii, where, upon the appearance of the sugar-cane leaf hopper, the parasites on this pest in its native countries were effectively introduced from Australia, Fiji and other places.

The importance of the prevention of the introduction of new pests with plant material from other countries is reflected in the extent to which Ordinances regulating the importation of such material have been adopted (*West Indian Bulletin*, 1912, **10**, 197; 1917, **15**, 158). By the strict application of Orders under these Ordinances, sugar-cane, as well as other crops, receives protection that should do much to prevent the loss and expense that have been caused by the careless importation in the past of vegetable produce, and seeds and other material for planting.

Fungoid Diseases.—Untoward changes and destruction in sugar-cane and other plants caused by fungi are usually mentioned as diseases. Such diseases generally attack a definite part or parts of the cane plant, and are best classified for practical purposes according to the part affected by them (see also *Cane Sugar*, Deerr, 1911; *West Indian Bulletin*, vol. x, etc.). The following list contains general particulars of the chief fungoid diseases of sugar-cane, classified in this way.

Among the most important preventive measures against the attack of sugar-cane by fungi is the selection of good planting material. A special measure employed against stem fungi is the soaking of the cuttings, that are to be used for planting, in Bordeaux mixture; this has received particular attention in Barbados, Antigua and Hawaii. For combating root fungi, the chief means comprise rotation and the treatment of the soil with quicklime; the latter method has been tried chiefly in the West Indies and Hawaii. Where there has been a serious outbreak of a stem disease it is useful to destroy all dead canes and trash by burning; the loss entailed in this destruction makes it, however, a better plan in ordinary practice to deal with the dead cane and trash in such a way that they are available to form humus. All causes of injury to the growing cane should of course, be avoided, especially

FUNGOID DISEASES OF THE SUGAR-CANE.

Common Name.	Scientific Name.	Distribution.	Remarks.
Stem Diseases :			
Black smut	*Ustilago sacchari*	Java, Natal, Queensland, India	—
Top rot	—	Java and probably Demerara	Cause uncertain.
Gumming disease	*Pseudomonas vascularum*	Queensland	—
Stem red rot	*Colletotrichum falcatum*	Java, Hawaii, W. Indies, India, Queensland	—
Pineapple disease	*Thielaviopsis ethaceticus*	General	A disease of cuttings, especially in dry weather.
—	*Cytospora sacchari*	India	Uncertain if harmful.
—	*Diplodia cacaoicola*	W. Indies, India	—
Black rot	*Sphæronema adiposum*	India	Often occurs with pineapple disease.
Gumming disease	—	Mauritius	Cause uncertain.
Rind fungus	—	W. Indies	Cause uncertain, probably due to *Diplodia* sp.
Collar rot	*Hendersonia sacchari*	India	—
Wilt disease.	*Cephalosporium sacchari*	India, W. Indies	—
Root Diseases :			
West Indian root disease	*Marasmius sacchari*	W. Indies, Java	Attacks the bases of stems of nursery seedlings in Java, chiefly on ratoons in the W. Indies.
Root fungi	—	Java	Doubtfully parasitic.
—	*Ithyphallus coralloides*	Hawaii	Doubtfully parasitic.
Leaf Diseases :			
Yellow spot disease	*Cercospora Kopkei*	Java	Does little damage.
Leaf spot disease	*Pestalozia fuscensens* var. *sacchari*	Java	Uncommon.
Eye-spot disease	*Cercospora sacchari*	Java, Hawaii	Probably only causes damage in wet season.
Red spot disease	*Cercospora* sp. (probably)	W. Indies, India, Java	—
Ring spot disease	*Leptosphaeria sacchari*	W. Indies, India, Java	—
Black spot of leaf base	*Cercospora acerosum*	Java	—
Brown leaf spot	*Cercospora longipes*	India	—
Cane rust	*Uredo Kühnii*	Java	Causes little loss.
Sugar-cane brand	*Ustilago sacchari*	General	—
Leaf-splitting disease	—	Fiji, Mauritius, Argentina, Hawaii	Cause uncertain.
Yellow stripe disease	—	Java, Cuba	Cause uncertain.
Mottling disease	—	Porto Rico	Cause uncertain, probably physiological; has spread with great rapidity, with serious results.
Djamoer oepas	—	Java	A disease known by the same common name attacks in Java rubber, cocoa, coffee, and many other plants, and is attributed to *Corticium javanicum*. Its effect on sugar-cane is negligible.
Leaf-Sheaf Diseases :			
Leaf-sheath eye spot	*Cercospora vaginæ*	W. Indies, Java	—
Leaf-sheath red rot	—	Java	Cause uncertain; found on young canes; prevents

that entailed by the thorough removal of the trash—"high trashing," as it is sometimes called. It has been shown by Cobb that the systematic killing of flies is useful in diminishing the extent to which the spores of fungi are disseminated by their means.

In a broad way, the healthiness of the sugar-cane in a country, and the avoidance of loss by the sudden spread of disease, are best ensured by clean cultivation, together with the selection and use of immune varieties, the control of importation, and the disinfection of all planting material that enters the country.

Other Pests.—Sugar-cane is sometimes attacked by eelworms or nematodes; these have, in fact, been supposed by some to cause the well-known sereh disease of Java, but the supposition is unconfirmed. The best remedy appears to be the cleaning of the land by means of trap crops—that is, by growing crops, such as the ochra (*Hibiscus esculentus*), that are particularly susceptible to attacks by eelworms—and digging them up carefully and burning them.

Among ordinary animal pests of sugar-cane are rats, hares and jackals; rats are found in canefields generally, whilst hares do most damage in India and Mauritius, and jackals in the former of these countries. The very untoward result of introducing the mongoose into Jamaica and other places, for destroying rats in canefields, is well known: rats are usually destroyed by poison; their control by disease introduced by means of various forms of "virus" has rarely been a success in the tropics. The other animals mentioned, hares and jackals, are best dealt with by using traps, or, for jackals, poison.

The Manufacture of Cane Sugar

Whether sugar is obtained from the sugar-cane or the sugar-beet it is necessary for the raw material to be treated in such a way that a liquid ("juice") is obtained which holds the sugar and yields this up in the subsequent evaporation to which it is subjected. In the case of the sugar-cane this liquid is usually obtained by crushing the canes between rollers in mills, so that some of the sugar is expressed with the juice that flows from it, and

treating the crushed fibrous material, called the "megass" or "bagasse," with warm water in order to obtain a further proportion of the sugar contained in solution in it; a process that is called "maceration." The sugar-beet, on the other hand, is not crushed, but sliced by means of sharp, revolving knives, and treated with hot water and hot juice in diffusers so that the slices give up most of their sugar. In a general way the treatment which the juice then receives in order that the sugar may be obtained from it is very similar in both cane sugar and beet sugar factories. It is clarified by suitable means, in order that it may be freed largely of the substances other than sugars (called usually "non-sugars") that it contains, is evaporated so as to reduce its bulk to a proportion convenient for working, is boiled in order that crystallisation of the sugar may take place, and then the boiled mass (called "massecuite") containing the sugar crystals is spun in centrifugals ("curing"), in order to separate the mother liquor (molasses) and produce a dry sugar.

Crushing

The cane is transported from the unloading place, where it is weighed, to the mills by means of a carrier, on which it is spread, crooked canes being sometimes cut on the way by revolving knives. Mills with three rollers are most commonly used, and the megass is passed through two or three of these in turn. So-called nine- and twelve-roller mills are simply three-roller units arranged one behind another, and fourteen-roller mills are composed of four three-roller units with a two-roller crusher taking the cane from the carrier; there are also mills with two, four, five or eight rollers, but these are less common. The work of the mills is often assisted by the provision of cane crushers, shredders or cutters which deliver the partly disintegrated cane to the first mill or rollers.

For maceration, in the simplest way, warm water is poured on the megass just as it is expanding when leaving the rollers; it is often the practice, however, where there is a very powerful first mill, to use the juice from the third mill between the first and second mills, and water between

the second and third mills. In any case, the effect is the same—the extraction of a greater amount of sugar from the cane than if this was simply crushed. The employment of large quantities of water for the purpose of extracting as much sugar as possible from the cane by its aid is impracticable, partly because of the large amount of liquid that would have to be evaporated later, and partly on account of the extent to which the juice would be rendered impure by the large quantities of non-sugars which would be extracted from the cane. In maceration the proportion of water added is often about one-fifth or one-quarter of the quantity of the natural juice of the cane : and with the assistance of this process over 95 per cent. of the sucrose, that is, the crystallisable sugar, in the cane may be removed in the diluted juice.

It should be stated that some attempt has been made to employ for the sugar-cane the diffusion method for the extraction of sucrose that is used for beet, and thus to avoid the loss of sugar that is carried away in the megass after crushing. In this process the canes are cut into chips which are subjected to the action of hot juice and water in diffusers, the usual plan being to have a dozen or more of these diffusers working in series so that the fresh chips are treated with the strongest juice, and as the chips become gradually exhausted they are treated successively with weaker juices, and finally almost the last traces of sugar are removed by hot water. A battery of diffusers may be composed of twelve to sixteen of these, each having a capacity of 700 to 800 gallons and capable of dealing with 1½ to 1¾ tons of cane chips at each filling. The employment of diffusion for sugar-cane in this way has had small application, partly because of the small increased recovery of sucrose, with a greater dilution than in maceration, and because of the lack of elasticity in the system as compared with that in the more convenient procedure in which crushing is employed. Systems exist in which the crushing of the cane is combined with diffusion for the megass, as in the Naudet Process used to some extent in Madeira and part of the West Indies ; but there is by no means any extensive application of such methods.

Clarification of the Juice

The juice from the mills passes through strainers, which keep back the larger pieces of the megass floating in it, and is then subjected to a process of clarification, either defecation or carbonatation. Before clarification the juice is passed through tanks for measuring.

In defecation the albuminoid, waxy and gummy matters in the juice are caused to separate from it by treating the juice, which is slightly acid, with an amount of lime sufficient to neutralise its acidity or make it slightly alkaline, a process called tempering, and then heating it before it passes into the defecators, in which it is further heated by means of steam jackets round the defecators. In these, the lighter impurities, such as the albumens, waxes and gums, form a scum and the heavier mineral impurities sink to the bottom, the middle layer of clear juice being run off after time has been allowed for settlement. Another method is to boil the juice in iron pans, instead of using defecators, so that all the impurities sink to the bottom, when the juice is run off into settling tanks; and there are still other means in employment for ridding the juice of the scum and mud as quickly as possible. Sometimes the juice requires the addition of so much lime for proper clarification that the excess has to be neutralised by means of the fumes from burning sulphur (sulphur dioxide); this is one of the forms of the process known as sulphitation, employed in sugar factories. The loss of sucrose entailed by clarification is very small: it should be only about 0·1 per cent., but is larger if the juice has been allowed to become sour.

Carbonatation is employed where white sugar is made. In this case the juice is mixed with a large excess of lime, heated, and then passed into tanks where it is treated with carbon dioxide made by "burning" lime, the temperature being kept below 130° F. In the process known as single carbonatation the limed juice is allowed to become just neutral by the action of the carbon dioxide; it is then heated to a temperature about twenty degrees Fahrenheit below boiling point and passed through filter presses. There is another process, called double carbonatation, in

which carbon dioxide is passed as in the former, but the gas is turned off as soon as the solids begin to settle quickly in the juice; this is then passed through filter presses without being heated again, the clear juice being then treated with a little lime, and heated while carbon dioxide is passed into it until the juice is neutral, the final stage consisting in boiling and filtration through filter presses.

Both kinds of carbonatation not only cause the elimination of gummy, albuminoid and waxy impurities, but lessen the amount of uncrystallisable sugar ("reducing sugars") by decomposing it and, in double carbonatation, also by converting it into other organic substances which unite with the lime and are retained in the filter presses. In the final effect, carbonatation removes from the juice more of the gummy matters than defecation, and double carbonatation more of the reducing sugars than the single process. Modifications of these systems of clarification exist mainly in the direction of employing carbonatation after defecation and of simultaneous carbonatation and sulphitation.

This general account of clarification does not take note of the many substances besides lime, carbon dioxide, and sulphur dioxide that have been suggested for use in the process, nor of the methods in which electric currents are employed. Most of these substances and methods have given promising results on the small scale which have not been realised with the quantities that have to be dealt with in practice.

Evaporation of the Juice

Before this takes place the juice may or may not be boiled ("elimination"), or filtered again, the matter being decided by the completeness of the clarification or the thoroughness of the separation of the scum. If it is boiled, it is made neutral again by means of alkali, if it is acid; or by phosphoric acid or sulphur dioxide, if it is alkaline. It is important, in any case, that the juice should pass as quickly as possible to the evaporators, of which there are usually three, each consisting of an air-tight vessel containing a drum with steam pipes for heating, and forming together the "triple effet"; the steam drums of the first

and second vessels are connected respectively with the main spaces (the "juice chambers"), outside the drums of the second and third vessels. In working, the juice in the first evaporator is heated by steam passing into its steam drum under pressure; as this steam is somewhat superheated it causes the juice in the vessel to boil even though the pressure in the juice chamber is often made a little higher than atmospheric pressure. The vapour from this, the first, juice chamber passes through the steam drum of the second vessel, causing the juice in its chamber to boil, as this is kept under reduced pressure. The vacuum in the juice chamber of the third vessel is still greater than that in the chamber of the second evaporator, the vapour passing from the latter to the former causes the juice in the third vessel to boil.

The process is imagined most easily when it is remembered that the steam drum and the juice chamber of each individual vessel are entirely independent, and that the steam drum of each of the first two vessels is connected with the juice chamber of the vessel that immediately succeeds it. The principle is the same if two or four vessels are used, instead of three, as is sometimes the case. The total effect is that the juice boils at a lower temperature in each succeeding vessel and the evaporation is carried out quickly with the minimum amount of fuel, and with virtually no change of the sucrose, through heating, to uncrystallisable sugar ("inversion"), and very little destruction of the sucrose (actually less than 0·01 per cent.). There are forms or modifications of evaporators other than those just described; but they are not in such general use as the double, triple or quadruple effet.

The partially concentrated liquid passing from the evaporators is called syrup, and contains about half its weight of water; whereas the juice from which it was made contains as much as 85 per cent. of water. A second clarification has usually to be carried out with this, as the impurities have become concentrated through evaporation and are not all left behind in the evaporators. Like the juice after clarification, syrup from defecated juice has to be boiled again in eliminators, and neutralised by means of lime or soda, or phosphoric acid, as the case may be; and

then allowed to subside. But syrup from juice that has undergone carbonatation usually needs only a simple filtration.

Boiling the Syrup

For the same reasons as obtain in evaporation this is carried out under reduced pressure; but in this case the reduction is such that the boiling is virtually carried out in a vacuum, and this fact gives its name to the "vacuum pan" in which the boiling is done. Good, well-clarified syrups may be "boiled to grain": that is, when sugar crystals begin to be formed, owing to the concentration of the syrup in the pan, successive lots of syrup are admitted from which the sugar is deposited on the crystals already formed. Or, as is usually the case with less pure syrups, and in the reboiling of molasses, the massecuite is removed from the pan before crystallisation, which is allowed to take place in coolers in which the mass is kept in motion by suitable means; this is called "boiling smooth."

Heating is effected by steam in coils, steam jackets or drums similar to those in evaporators, the contents of the pan being often kept in motion by mechanical means or by the injection of steam; when boiling to grain is taking place the successive admissions of syrup cause an ebullition that has a similar effect, and the addition of molasses is sometimes employed for the same purpose. The "pan-boiler," *i.e.* the man controlling the working of the vacuum pan, is helped to gauge the different stages of the process by being enabled to withdraw samples of the massecuite from the pan by means of a "proof-stick"; he has, however, to possess much experience of the work in order to avoid failure and to ensure the making of a product such as is desired. In the finished massecuite the proportion of water has been reduced to one-tenth of its weight, or somewhat less. The use of the vacuum pan is not confined to boiling syrup or mixtures of massecuite and molasses to the stage of crystallisation; but there are other uses, such as the reboiling of molasses for the further recovery of sugar, and the making of "concrete sugar." There is very little loss of sucrose in boiling,

although there may be serious decomposition and inversion when the process is being carried out with molasses.

The Curing of Sugar

This is the separation of the sugar from the molasses, and, as has been indicated, it is carried out in centrifugals. It is usual for the massecuite to be cooled before curing, the mass being kept in motion in order to prevent the additional sugar which will naturally come out of solution from forming minute crystals (" false grain ") that will leave the centrifugals with the molasses; in the case of massecuites from impure syrups or when molasses has been introduced into the pan, in which circumstances much false grain is formed in the pan, cooling in motion is necessary, or the same effect is ensured by curing the massecuite hot. Massecuites from well-clarified syrups, on the other hand, contain so small an amount of false grain when they leave the pan that they may be cooled while at rest. During cooling the percentage of crystallised substance (sugar) in the massecuite naturally increases; and where the proportion of sucrose in the total solids is high this increase may be from 45 per cent. to over 50 per cent.

It is necessary to break up in a pug mill massecuites that have cooled at rest in the crystallisers, before curing; and for the purpose they are usually mixed with molasses in the mill. The sugar from such massecuites is purged by a spray of water just before it is ready to be discharged from the centrifugals, the purging being completed with the aid of a steam jet directed on to the sugar. Curing and purging are not usually as simple as this in practice, as various modifications and methods have to be used to prevent the loss of sugar washed away in purging and to determine the colour and form of the final product.

It should be added in a very general way that, when it is desired to recover as much as possible of the sugar that remains in the molasses, a procedure is employed in which molasses is boiled in vacuum pans with syrup of the proper strength three times, with curing between the different boilings, so that exhausted molasses containing little sugar is finally obtained. For making white sugar two sets of centrifugals are usually employed: one for curing

and one for purging. Sugars, especially those from which the molasses adhering after centrifuging has not been removed by purging, are sometimes dried further, by means of hot air, in an inclined rotating iron cylinder; as the sugar falls through the cylinder it is retained momentarily on ledges inside. The sugar is then sifted and packed by machinery into bags filled automatically to a constant weight.

IMPERIAL INSTITUTE RAW MATERIALS COMMITTEE

THE following reports of work of the Imperial Institute relating to raw materials were considered at a recent meeting of the Raw Materials Committee of the Imperial Institute, which is nominated by the Association of British Chambers of Commerce.

(a) PROGRESS REPORTS

Materials Suitable for Paper Pulp.—In connection with the investigation at the Imperial Institute of spent wattle bark as a paper-making material, it was reported to the Committee that a Company in Natal is now making arrangements for the production of paper from the spent bark obtained from the tanning extract factories. Steps are also being taken to prepare pulp from papyrus in Zululand (cf. this BULLETIN, 1920, **18**, 540).

Hat-making Materials.—At the request of the Luton Chamber of Commerce the Imperial Institute has for some time been investigating the possibility of obtaining within the Empire supplies of raw materials suitable for use by British hat-makers, and a considerable number of samples of straw and plaits have been procured from British countries overseas for examination.

Since the last meeting of the Committee further samples have been received from West Africa, South Africa and the West Indies, and forwarded to the Chamber. Certain of the materials would be suitable for use in this country if they can be offered at prices comparable with those of similar products from China and Japan. En-

quiries on this point are now being made by the Imperial Institute.

Substitutes for Sheffield Lime.—At the request of the Birmingham Chamber of Commerce the Imperial Institute has investigated the question of preparing an efficient substitute for Sheffield Lime, which is largely used in the local industries for polishing non-ferrous metals, and of which supplies are stated to be inadequate. After numerous experiments at the Imperial Institute, samples of certain materials were submitted to the Chamber for trial by manufacturers and a favourable report has been received on one of the products. The question of the production of the material on a commercial scale is now receiving attention.

(*b*) New Subjects

Posidonia Fibre from Australia.—This fibre, which is derived from a marine plant, is found on the foreshore of Spencer Gulf, South Australia, under a deposit of sand. Samples examined at the Imperial Institute some time ago consisted of short harsh fibre, somewhat resembling jute, which, it was suggested, would be suitable for paper-making or for spinning into coarse yarns for the manufacture of carpets and similar fabrics. It is now proposed to utilise this fibre for textile purposes, either alone or in admixture with other fibres, and specimens of yarns, felt, fabrics and carpet made from the fibre were recently received by the Imperial Institute. The Company interested in the enterprise have asked to be placed in touch with possible users in this country, and action is to be taken to this end.

Wood for Boot Lasts.—The assistance of the Imperial Institute has been requested by the Federation of British Industries with regard to the supply of suitable woods for the boot-last industry in Northampton. Rock maple from America is the best wood for the purpose, but is now scarce and expensive. The question has been considered by the Imperial Institute Advisory Committee on Timbers and a list of woods considered to be worth trial has been supplied to the Federation. Steps are being taken by the Imperial Institute to obtain for practical trial samples of

certain woods from British sources which appear to be suitable for the purpose.

Bamboos for Paper-making.—Reference was made to the action which is being taken in various parts of the Empire to start the production of paper pulp from bamboos on a commercial scale (cf. this BULLETIN, 1920, **18**, 403). Samples of the pulp and paper made from a consignment of bamboos recently received at the Imperial Institute were shown.

Tobacco Production in the Empire.—A statement was made as to the cultivation of tobacco within the Empire, with special reference to those countries which are producing, or could produce, tobaccos suitable for the United Kingdom market.

Cultivation of the African Oil Palm.—Attention was drawn to the interest which is being taken in the cultivation of the African oil palm in Malaya and the Dutch East Indies and to the satisfactory results which have already been obtained in these countries. In view of the importance of this question to the British Colonies in West Africa, a full account of the whole subject was given in this BULLETIN (1920, **18**, 209).

CO-OPERATION WITH THE DEPARTMENT OF OVERSEAS TRADE

A report was made as to the work carried out by the Imperial Institute in conjunction with the Department of Overseas Trade.

NOTES

The late Mr. J. S. J. McCall.—It is with deep regret that we have to announce the death of Mr. J. S. J. McCall, whose name has for more than ten years past been prominently before the agricultural world as Director of Agriculture in Nyasaland. Mr. McCall, who was born in Lanarkshire in 1882, received his early agricultural training at the West of Scotland Agricultural College. His first official post was lecturer on agriculture and biology at the Egyptian Government Agricultural College at Ghizeh, which he retained for three years until his appointment to the newly created post of Director of Agriculture in Nyasaland in 1908. Before taking over his official duties he visited the United States and Ceylon for the purpose of studying the cultivation of cotton and rubber.

Mr. McCall will chiefly be remembered for his work on what are now the two staple crops of Nyasaland—cotton and tobacco. When he was first appointed to the post of Director of Agriculture numerous varieties of cotton were being sown with little or no discrimination. This led to hybridisation and the mixing of seed in the ginneries, with the result that the quality of the cotton was considerably reduced. A strenuous campaign was at once undertaken and large quantities of seed were destroyed. The only varieties retained were Egyptian kinds and a long-stapled American variety, known in its present form as Nyasaland Upland. During Mr. McCall's tenure of office the cotton exports rose from 756,120 lb. in 1908 to a maximum of 3,462,478 lb. in 1916.

In 1917 Mr. McCall acted as Food Commissioner for the Protectorate and Chairman of the Military Food Production and Collection Committee, with the temporary rank of major in the Nyasaland Field Force. These additional labours coming at the close of ten years' service in the somewhat unhealthy climate of Nyasaland told upon his constitution, and in August 1918 he was invalided home. He returned to Zomba early in 1920, and a little later was appointed Director of Agriculture in the Tanganyika Territory. He died soon after his appointment to Tanganyika, at an age when many further years of useful work might have been expected from such an energetic and well-equipped agriculturist.

Flax-growing in Kenya Colony.—In this BULLETIN (1914, **12**, 211) reference was made to the experimental cultivation of flax in the East Africa Protectorate (now

known as Kenya Colony) and a report was published on the results of the examination at the Imperial Institute of four samples of flax grown at the Government Experiment Farm at Kabete. In later issues (1917, **15**, 123; 1919, **17**, 129) short accounts have been given of the establishment and progress of the flax industry in that country.

The following notes are extracted from an *Interim Report on the Progress of the Flax Industry in Kenya Colony* by the Hon. Mr. Alex. Holm, Director of Agriculture. The acreage devoted to flax and the number of mills and scutching-wheels in the Colony in 1919–20 are tabulated below.

District.	Total area sown between July 1, 1919, and June 30, 1920.		Area sown but not harvested, June 30, 1920.	Flax machinery erected or in course of erection, June 30, 1920.	
	Acres.	Percentage of total area.	Acres.	Mills.	Scutching-wheels.
Eldama Ravine	1,461	4·4	1,027	3	90
Fort Hall	102	0·3	94	1	2
Kisumu	45	0·1	29	—	—
Kyambu	2,368	7·1	1,881	6	75
Lumbwa, including Kericho	3,239	9·7	2,049	7	102
Machakos	4	—	0	—	—
Nairobi	122	0·4	122	—	—
Naivasha, including Gilgil	1,516	4·6	765	5	81
Nakuru, including Njoro Solai, etc.	10,421	31·2	7,382	14	275
Nyeri	39	0·1	36	1	12
Rumuruti	56	0·2	56	1	8
Trans Nzoia	2,094	6·3	1,623	7	80
Uasin Gishu	11,882	35·6	9,359	23	527
Total	33,349	100·0	24,423	68	1,252

The quantities of flax exported from the Colony in 1918–19 amounted to 283 tons of value £10,049, and in 1919–20 to 408 tons of value £11,577; whilst during the six months, April 1—September 30, 219 tons of value £7,665 were exported.

It was estimated that, on a very moderate basis of computation, the crop of 1919–20 would be as follows: flax fibre, 2,500 tons at £120 per ton, £300,000; tow, 2,500 tons at £40 per ton, £100,000; seed, 2,250 tons at £25 per ton, £56,250; making a total return of £456,250.

A Flax Association, representative of the flax interests of the whole Colony, was formed in May 1920. This Association has inaugurated a scheme for the grading of flax which will at first be permissive, but when sufficient experience has been gained the introduction of compulsory

grading will be considered. Sanction has been obtained for the appointment of two additional flax officers in the Department of Agriculture, which will be responsible for the grading. Fees will be charged to cover the cost of inspection and grading.

Flax constituted one of the most important features of the Nakuru Agricultural Show of 1920. There were more than 300 entries in this section, and the quality of many of the exhibits was highly commended, and was said to compare favourably with that of high-class European flaxes. These exhibits have stimulated the industry and encouraged increased activity on the part of growers and others interested in the flax trade.

Many of the flax-growers in Kenya Colony are inexperienced in farming and the cultural conditions are often unsatisfactory. As the farmers gain experience, however, and the virgin land becomes ameliorated by continued cultivation, better results will be secured. The areas cultivated on individual holdings are generally larger than those in Ireland, Belgium and other flax-growing countries, as much as several hundred acres being not uncommonly planted by individual farmers. It appears that flax cultivation can be best practised in the higher altitudes, which have a cooler climate and a heavier rainfall than the lower lands.

The only disease of any importance which has hitherto attacked the flax plants is flax-wilt, but this has not yet spread to any great extent, and is not likely to cause serious losses if proper farming methods and the precautions recommended by the Department of Agriculture are adopted.

Considerable areas of flax were infested in 1919–20 by a caterpillar, but the damage done was small in proportion to the total area under cultivation. An appliance has been invented by which the caterpillars can be removed from the crop with comparatively little expense, and the pest can now be readily controlled.

Trials with different varieties of flax and experiments on various methods of retting have been carried out at the Kabete Experiment Farm with valuable results, and this work is being continued.

Much disappointment has been expressed by the flax-growers at the decline in the prices of the fibre, but it is considered that, even at greatly reduced prices, flax may prove more profitable than other crops.

The Preparation of Palm Oil for Edible Purposes.—*Hitherto* practically all the palm oil entering commerce has contained a large amount of free fatty acids, and cannot

be employed for edible purposes without first being refined by chemical methods. Many attempts have been made in West Africa to produce an oil containing as little as 8 per cent. of free fatty acids, but so far with little success. Even in Sumatra, where the oil palm is now being cultivated in plantations (cf. this BULLETIN, 1920, **18**, 209), the acid content of oil from small lots of selected fruits from estates just coming into bearing is generally more than 7 per cent., whilst on estates working large quantities of fruits in primitive factories the oil seldom contains less than 15 per cent. of free fatty acids. Ammann (*L'Agron. Col.*, 1918, **3**, 33) showed that an almost neutral oil can be prepared by using fresh unfermented fruits only, whilst Van Heurn has recently published the results of investigations carried out at the General Experimental Station of the Algemeene Vereeniging van Rubberplanters ter Oostkust van Sumatra, as a result of which it is considered that, by taking certain precautions to avoid the causes of high acidity, it should be quite practicable to prepare an oil suitable for edible purposes (*Med. van het. Algemeen Proefstation der A.V.R.O.S., Algemeene Serie*, No. 8, 1920, p. 16).

The factors which tend towards the production of a large amount of free fatty acids in palm oil are stated by Van Heurn to be as follows: (1) The bunches, while still on the trees, contain loose ripe fruits, and experiments showed that these loose fruits give an oil with a considerable acid content. The decomposition of the oil starts at the surface of the loose fruits where they have been joined to the bunch, and is accelerated by the presence of moisture and the growth of moulds and bacteria. Fruits, however, which have become loosened after gathering the bunch can give an oil with a low acid content if they are immediately separated from the bunch, and are carefully stored in the open air. (2) Ripe fruits which have fallen being allowed to remain under the trees, where they are apt to ferment. (3) The damaging of the fruits during harvesting transport, storage or during the separation from the bunches. The decomposition of the oil begins immediately after the cells are broken, and the lipolytic enzymes, which bring about the production of fatty acids, are brought into contact with the oil. The reaction starts very rapidly, but after about 40 per cent. of the fatty acids have been liberated, proceeds more or less proportionally to the time. (4) The separation of the pulp before it has been thoroughly heated. The object of the heating is to destroy all the lipolytic enzymes. If this is not effected, on pressing the pulp these enzymes would come into contact with the

oil, and would cause the liberation of fatty acids. (5) The working up of all the fruits without first grading them. If the grading is not carried out, good ripe fruits containing only slightly acid oil will be worked with loose, damaged or fermented fruits in which the oil has a high acid content. The fruits on the same bunch even are not homogeneous, but show different stages of ripeness, soundness and development. (6) Delay in the working of the fruits, particularly the loose ones, and the storage of the fruits or bunches in heaps.

The first two causes can be prevented by changing the present system of harvesting. Instead of employing gangs of labourers working large divisions, each workman should be given charge of a definite portion of the estate, for which part he would be held responsible. By this means each tree would receive more frequent attention and fallen fruits would not be allowed to remain on the ground for so long. The bunches after being cut down should be brought to the factory, where they are hung on racks to ripen fully, and as soon as the fruits become loose they should be separated and graded into two or three qualities.

The Coagulated Latex of the South American Cow-tree.— Under this title an account was given in this BULLETIN (1919, **17**, 294) of the examination at the Imperial Institute of the coagulated latex of a tree found in Colombia. The material was of a highly resinous nature, and somewhat resembled pontianac, for which it could probably be used as a substitute in the rubber industry. It was also suitable for the manufacture of chewing-gum, being classed by brokers as "gum-chicle." Mr. M. T. Dawe stated, in forwarding the product, that it is known locally as "Leche de perillo," the tree from which it was derived being known as "Palo de vaca," or "Palo de leche." It was believed at the time that the tree was *Galactodendron utile*, H. B. & K. (*Brosimum Galactodendron*, Don.), which is the ordinary cow-tree, common in the tropical forest regions of South America. Mr. Dawe, however, has recently informed the Imperial Institute that botanical specimens of the tree have been examined at Kew, and pronounced to belong to a species of *Couma*. The material could not be precisely identified, and further specimens are being obtained for this purpose.

The genus *Couma*, belonging to the natural order Apocynaceæ, comprises five species of trees found in tropical South America. They are closely related botanically to the Landolphias, the rubber vines of Africa. The best-known species is *Couma guianensis*, Aubl., the latex

of which is used as a beverage by the Indians, in the same way as that of *Galactodendron utile*, and for this reason the tree is often known, like the latter, as the South American cow-tree. The latex of the tree has been examined by Heim (*L'Agric. Prat. de Pays Chauds*, 1910, **10**, i, 145), who found it to consist mainly of a resinous gutta, apparently similar to the material examined at the Imperial Institute.

Agriculture and Forest Resources of Colombia.—An account of a journey in Colombia, South America, from Tolima to the Pacific Coast through the Departments of Caldas and El Valle, forms the subject of a brochure issued by the Colombian Bureau of Information and Trade Propaganda in London. The journey was made by Mr. M. T. Dawe in his capacity as Agricultural Adviser to the Colombian Ministry of Agriculture and Commerce, and occupied the latter part of the year 1918 and the early part of 1919.

Starting from San Lorenzo in the Magdalena Valley, the route crossed the snow-covered Mount Ruiz in the Central Cordillera to Manizales, the capital of the Caldas Department; thence northwards to Agudas, whence it returned southwards to La Virginia, a port on the Cauca River, from which point a détour was made up the Quindio as far as Perales on the Central Cordillera. Descending to the town of Cartago in the El Valle Department, the Cauca River was followed to its mouth at the port of Buenaventura on the Pacific Coast. The return journey followed a similar route, but from Cali in the south to Cartago in the north the important Cauca Valley was traversed overland. From Manizales the return over the Cordilleras was by way of Solidad to Mariquita, whence the Magdalena Valley was again reached by rail.

The lower foothills of the eastern slopes of the Central Cordilleras from San Lorenzo to Mount Ruiz are poorly clothed with vegetation, but in the central area near Libano the soil is richer and sub-tropical vegetation abundant. The principal crops of this region are coffee, maize, beans, wheat, potatoes and cocoa; and on a smaller scale are grown rice, tobacco, plantains, barley, sugarcane, onions and peas. The central part of the Cordillera contains a good deal of forest, and near Murillo are almost pure forests of Colombian oak or roble (*Quercus* sp.).

Other important timber trees that occur here are pino (*Juniperus* sp.), chaquero (*Podocarpus* sp.), cedars (*Cedrela* spp.), comino and comino crespo (*Aniba perutilis*), nogal or walnut (*Cedrela nogal*), arenillo, quimulà marío, laurel, aceituno, fresno, aguacatillo, vilivil, chilco, cacao,

diomate, graniso, etc. An interesting species of this region is *Myristica Otoba*, a small tree related to the species that yields the nutmeg of commerce. The seed of this species is slightly larger than the nutmeg, and is surrounded by a paler-coloured mace. By boiling and pressing this seed a solid fat is obtained, which is used locally for skin affections, and as a remedy for the attacks of warbles (nuche) and ticks. The trees are said to give two crops of seed a year, and as much as 15 lb. of fat is obtained from a single crop of a mature and healthy tree. The fat is sold locally at about 40 cents. per lb. (cf. this BULLETIN, 1919, **17**, 249).

In the volcanic region near Manizales also occurs the arboloco or mad tree (*Montanoa Moriliriana*), a member of the natural order Compositæ, from the hollow bole of which a durable timber is obtained which is used locally as flooring, and is also of repute for the manufacture of billiard cues.

At Neira, Aranzazu, Salamina and Pacora, all towns on the western slopes of the Central Cordillera, are coffee and flour mills, and sugar factories where a coarse brown sugar, known as panela, is produced.

The town of Agudas at the northern limit of the Department of Caldas is the seat of an important industry in Panama hats. The material employed in the manufacture of the hats consists of the leaves of a palm (*Carludovica* sp.) which are gathered young, and cut into thin strips and bleached. This material is sold in the markets of Pacora and Aguadas, and is bought by the country people, who take it to their homes, where both sexes engage in the work of manufacturing it into hats. The finished article is sold in the markets of the same town, and as many as eight grades are known varying from " ordinarios " (ordinary) to " muy finos " (very fine). These towns are visited by commercial travellers, chiefly from the United States, who purchase the hats for export.

In the Cauca Valley west of Pacora the climate is quite tropical, and the chief feature of the vegetation is the Cuesco or Corozo palm, from the kernel of which an oil similar to that from the palm kernels of West Africa is obtained (cf. this BULLETIN, 1917, **15**, 479).

On the west side of the Cauca Valley, at Marmoto, is the richest gold-mine in Colombia. It was known to the Spaniards in the sixteenth century, and is now worked by an English company, the Colombian Mining and Exploration Co.

Within the range of a temperate climate, almost throughout the route, it was observed that fiqué (*Fourcroya*

sp.) was being grown for fibre for the local manufacture of sacks and cordage. This comparatively new industry is the result of the difficulty experienced in obtaining jute bags for the coffee industry during the European War.

In the neighbourhood of Salento, a town situated at 1,800 metres on the western slope of the Central Cordilleras, the wax palm of Colombia (*Ceroxylon andicola*) occurs in abundance. From the bole of this palm is obtained, by scraping, a vegetable wax in a dust-like form which, after being melted and formed into cakes, resembles the Carnauba wax of commerce (cf. this BULLETIN, 1917, **15**, 182). There appears to be two forms of this palm on the Central Cordillera: the common form a tall tree, and a dwarfer type with the ring-markings on the trunk much closer together, and more spreading fronds with a brownish-coloured wax on the under surface. The second kind usually affects the higher altitudes.

In this locality also occurs a plant known as quiteria (*Spigelia pedunculata*), the root of which is much esteemed locally as a vermifuge.

The route up the Quindio range of the Central Cordillera was through fertile lands on the lower slopes, where there is extensive cultivation of coffee, sugar-cane, maize and yuca (cassava). Above these are forest lands comprising pino, chaquero and roble or oak, the last-named increasing until in the upper zone almost pure forests occur. When the limit of the oak range is reached a tree known as ensenilla (*Weinmannia* sp.) occurs. This tree yields a valuable tanning bark, and a wood that burns freely in a green state. Another interesting tree of this region is palo de aji (*Drimys granatensis*), which furnishes a bark similar to that of Winter's bark of commerce. Near the ridge is situated the Quindio mercury mine, which is being operated by an English company.

The route entered the Department of El Valle at the town of Cartago, the capital of the province of the same name. This municipality is an important centre for the production of cocoa, panela (coarse sugar) coffee and tobacco, and for cattle farming.

The only modern sugar factory, and the second largest in Colombia, is at La Manuelita near Palmira. This was installed before the Pacific Railway was constructed, and the whole of the machinery had to be transported over the western Cordillera from the port of Buenaventura. At La Manuelita are also experimental plantations for the introduction of new forms of sugar-cane, and extensive grazing lands where improved types of horses and cattle have been reared by crossing the local kinds with imported animals.

The greater part of the Cauca Valley, especially the alluvial lands near the river and its tributaries, is of excellent quality, and is suitable for the production of a great variety of tropical crops as well as for cattle-raising. There is ample scope in this region for the introduction of modern agricultural machinery, as this could be brought to the port at Buenaventura and distributed inland by rail and river, but so far little has been done in this direction. Cattle-raising is the most important industry of this locality, and crops such as cocoa, sugar-cane and maize are grown to a considerable extent, but the locality is also suited to such crops as tobacco, rice, cotton, coconuts and beans. The report concludes with recommendations regarding these crops and suggestions for the further development of the cattle industry in this region. Appended to the report are statistics regarding population, rainfall and trade of the districts mentioned.

Tungsten in China.—Tungsten ore deposits were first worked in China in 1914, but on quite a small scale (*Tungsten Ores*, by R. H. Rastall and W. H. Wilcockson, Imp. Inst. Monograph, 1920, p. 58), and it was only after the considerable rise in the price of the metal, due to the needs of the war, that any large quantity of ore or concentrate was exported. The first good output was realised in 1917, when 1,200 tons of high-grade concentrate were produced. In 1918 the exports of wolframite concentrate (60 per cent. WO_3) amounted to no less than 9,255 long tons, but the total production during the year exceeded that figure, large quantities of ore and concentrate having to be left in the mining districts as they could not be sold owing to the cessation of hostilities. The price fell considerably after the war, largely owing to the enormous accumulation of stocks in the United Kingdom, the United States and other countries, and as a consequence tungsten mining in China ceased, as it did in most of the tungsten-producing countries of the world. The Chinese deposits were worked until February 1919, the exports during the whole of 1919 amounting to about 5,903 long tons of concentrate, of which a large quantity no doubt was actually raised in 1918.

The principal tungsten deposits are found in the southern part of China, and have a very wide distribution. They occur in the southern part of the provinces of Hunan and Kiangsi, and in the northern and eastern parts of the province of Kwangtung, and large areas exist which have not yet been opened up.

From the little that has been written about the tungsten deposits of China, it would appear that the ore, which is

wolframite, has five modes of occurrence: (1) in detritus; (2) in alluvial; (3) in ordinary quartz veins; (4) in intrusive quartz veins or dykes; and (5) in stockworks.

(1) The detrital deposits are found round the flanks and foot of a mountain, from 4,000 to 6,000 feet above sea-level, and from 2,000 to 3,000 feet above the surrounding hills. These deposits are due principally to weathering.

(2) The alluvial deposits consist of gravels, sands or pebbles in the beds and banks of streams. The wolframite is sometimes accompanied by cassiterite or magnetite.

(3) The ordinary quartz veins traverse granite and patches of schist or phyllite. They are usually thin, but vary in thickness from a few inches to several feet.

(4) The quartz veins or dykes, sometimes of considerable thickness, are intrusive in granite or metamorphic rocks.

(5) The stockworks consist of a number of small quartz veins in granite, schist or phyllite.

The deposits examined by W. R. Jones ("Tin and Tungsten Deposits: The Economic Significance of their Relative Temperatures of Formation," *Bull. Inst. Min. and Met.*, No. 186, March, 1920, p. 15) are remarkable as containing only a small quantity of tin (the concentrate may carry from 0·5 to 1 per cent. tin, or none at all), and apparently no tourmaline.

In the Kowloon deposits, near Hong Kong, pyrite and arsenopyrite are found in the least weathered parts of the lodes. In the Pingshan and San To Chuk stockwork deposits of Kwantung, pyrite is only sparingly present in the weathered outcrops.

The quartz veins of the Kuku mines, east of Shiuchow, Kwantung, are characterised by the presence of bismuth and some flakes of molybdenite. W. R. Jones found the percentage of bismuth higher in lodes outcropping on the flanks of the ridges than in the lodes nearer the top of the mountains. Bismuth is also found in the Gong-Hong stockworks, Kwantung, in which white mica is particularly abundant and pyrite and a little arsenopyrite also occur.

In the Tin Nam deposits, in the southern part of Kiangsi, wolframite, with abundant white mica and pyrite, is present in a series of quartz veins intrusive in metamorphosed sedimentaries, chiefly phyllites, and in the Yukongshien deposits of Hunan wolframite also appears in very wide quartz veins intrusive in granite, schists and quartzites. Arsenopyrite is very abundant in some of these veins.

In that portion on the mainland of the British colony of Hong Kong known as the "New Territory" (held under the treaty of 1860), six outcrops of tungsten-bearing ore

were known by the end of 1917, three of which had been developed, and had yielded ore containing 18 per cent. of tungsten. The veins are described as being from 10 to 18 inches in thickness. According to the U.S. Consul-General, George E. Anderson, "it is altogether within the range of possibility that the deposits are among the most important in the world." At that time the deposits were being exploited by an Anglo-American syndicate under licence from the Hong Kong Government (*U.S. Comm. Repts.*, No. 42, 1918, p. 663).

The wolfram deposits in Chinese territory are usually worked by farmers. A few of the mines are owned by companies, the ore being extracted on a tribute system. Rakes, toms and pans are used for washing the alluvial ores, whilst, in the case of vein mines, hand hammers, drills and sometimes black powder are used. The concentrate is prepared by the hand-picking of large pieces, and the hand-sluicing of small pieces. The concentrate is somewhat impure, and often has to be reconcentrated in plants owned by native or foreign companies. The Yui Hwa Mineral Supply Co. has dressing plant, consisting of shaking screens, jigs, rocking tables and round revolving tables, by which it can produce concentrate of from 67 to 72 per cent. of tungstic oxide (WO_3), with about 5 per cent. of manganese, and only a small amount of impurities, such as copper and tin (*U.S. Comm. Repts.*, No. 299, 1919, p. 1657).

C. Y. Wang ("Wolfram Mining in China," *Eng. and Min. Journ.*, Jan. 3, 1920, p. 6), gives six representative analyses of wolframite concentrate from Kwantung, Hunan and Kiangsi. The analyses show from 62·6 to 70·9 per cent. of tungstic oxide (WO_3). No tin was found in two samples, and in two others it amounted respectively to 0·18 and 0·34 per cent. The amount of ferrous oxide (FeO) present varied from 10·1 to 15·6 per cent., and that of manganous oxide (MnO), from 8·4 to 11·1 per cent.

C. E. Kline estimates the cost of placing a short ton (2,000 lb.) of wolframite concentrate on the market at 460 customs taels, or £145 13*s.* (at the average rate of exchange in 1919, viz. 6*s.* 4*d.* per tael). The war time prices ranged from about £253 to £316, and that from November 1918 to January 1919 averaged about £158 per ton. The price in London in February 1921 was 15*s.* per unit, or £45 per ton of concentrate containing 60 per cent. tungstic oxide (WO_3). It is obvious, therefore, that if the above estimate be correct, no wolframite can be mined in China at a profit to-day. In Chinese territory the industry is heavily taxed (in customs dues, licence fees and local taxes), the taxes amounting to 22 per cent. of the

actual cost. Even if no allowance is made for this, the cost will still be more than double the present market value of the concentrate. If China is now shipping concentrate it must be from stocks, which are being put on the market at a considerable loss.

In 1918 it was intended to establish a plant at Hankow for making ferro-tungsten, and there is said to be a small smelting plant at Dalny which is still in an experimental stage.

There is no doubt that wolframite has a very wide distribution in South China—rough estimates of the ore in sight range as high as 100,000 tons—so that China again becomes a severe competitor in the production of tungsten ore.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the BULLETIN *a summary is given of the contents of the more important papers and reports received during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India and the Tropics generally. It must be understood that the Imperial Institute accepts no responsibility for the opinions expressed in the papers and reports summarised.*

AGRICULTURE

Foodstuffs and Fodders

Sugar.—A preliminary study of the cost of producing sugar in Mauritius is recorded in *Bulletin* No. 5, Part I, 1920, *Statistical Series, Dept. Agric., Mauritius*. From the data which have been collected from factories, representing more than half the total number in the colony, it is shown that the average sale price per 50 kilos of sugar, taking into account all receipts and charges, was Rs. 7·94 for the years 1909–13, and Rs. 11·97 for 1914–18, yielding a net profit of Rs. 0·59 and Rs. 2·08 respectively. It will be seen that, had it not been for the conditions that arose as an effect of the war, the position of Mauritius planters in 1914 would doubtless have been critical.

Wild Food Plants of the Philippines.—Some 180 plants which are of interest as wild sources of food supply are briefly described in *Bulletin* No. 21, 1920, *Bureau of Forestry, Philippine Islands*. The information given includes a short account of the edible portion of the plant, a brief general description of the species, together with botanical and native names, and illustrations. Among the most

abundant edible fruits may be mentioned the pili nut (*Canarium luzonicum*), considered by some people to be superior to the almond, and forming a staple article of commerce in the Philippines. One of the wild mangoes (*Mangifera caesia*) has an excellent flavour, and is commonly seen in local markets together with other fruits, viz. the duhat (*Eugenia cumini*), mabolo (*Diospyros discolor*), guava (*Psidium guajava*), santol (*Sandoricum koetjape*), kamachile (*Pithecolobium dulce*) and bignai (*Antidesma bunius*).

Sunflower silage and green forage.—*Bulletin* No. 131, 1919. *Agric. Expt. Sta., Bozeman, Montana*, records the results of trials with Mammoth Russian sunflower during the years 1915 to 1918. From preliminary trials on the method and date of planting, it was found that the highest yields were obtained from the earliest sowings and when the seed was sown in drills from 30 to 36 in. apart, the returns under these conditions being 44 tons per acre; the plants were cut from the time they began to bloom until the seeds began to harden. Experiments on the feeding of sunflower silage, and its composition and digestibility, have shown that silage made from plants of which 30 per cent. are in bloom has a higher feeding value than that from less mature plants, and compares favourably with maize silage. It is stated that 2·83 lb. of sunflower silage were found equal to 1 lb. of alfalfa hay when fed to dairy cows receiving grain and a limited hay ration, and that 3·75 lb. were equal to 1 lb. of choice alsike clover hay under the same conditions. The silage is palatable and causes no objectionable properties in the milk. Chopped green sunflower was found to be of equal value to green maize when fed as a supplementary fodder to pasture during the latter part of the grazing season. Further studies on the question of the digestibility of sunflower silage form the subject of *Bulletin* No. 134, 1920, of the same station.

Oils and Oil Seeds

Balanites sp.—In the *Journal d'Agriculture tropicale* (1912, **12**, 233) were published the results of the examination of the seeds of a tree which was considered to be *Trachylobium mossambicense* of Portuguese East Africa (cf. this Bulletin, 1913, **11**, 157). Jumelle, in *Les Matières Grasses* (1921, **13**, 5725) discusses the accuracy of this botanical determination and is of the opinion that the tree in question is *Balanites Maughamii*, which has been described in the *Kew Bulletin* (1913, p. 131 ; abstr. this Bulletin, 1913, **11**, 516). The fruit and oil of *Balanites*

Maughamii from Portuguese East Africa have been examined at the Imperial Institute, and the results have been published in this BULLETIN (1912, **10**, 548).

Brassica sp.—During the war, owing to the impossibility of obtaining supplies of mustard seed, seeds from other sources were shipped as substitutes, among which was Chinese colza seed (*Brassica campestris chinoleifera*, Vieh.). This seed which was originally imported as a substitute for rape seed, possesses no medicinal or satisfactory condimental value, so that its use in place of mustard seed was not successful. An account of the examination of Chinese colza seed is given in *Journ. Agric. Res.* (1920, **20**, 117). The seeds are yellow or brown in colour, the former predominating, and are more or less flat with a smooth surface. The seeds contain a glucoside, which, after autolysis, yielded on steam distillation from 0·4 to 0·6 per cent. of crotonyl isothiocyanate. The yield of fixed oil varied from 40 to 50 per cent. The oil, which is reported to be used in China and also recently in the United States of America, was light yellow in colour and had the general characteristics of rape oils. Physiological trials showed that the volatile oil obtained on steam distillation possessed no blistering or bactericidal properties. The results of the chemical investigation indicate that Chinese colza seeds closely resemble rape seed and are not suitable as a substitute for mustard seed. The seeds contained from 23 to 25 per cent. of proteins, and therefore the oil-cake prepared from them should be a valuable feeding material. It is suggested that the leaves might be of value as a green vegetable, whilst the plant, which is very vigorous and apparently hardy, seems to offer possibilities as a forage crop. Experiments in this direction are being undertaken.

Coconuts.—An account of a caterpillar pest which attacks the leaves of coconut palms in Indo-China is published in the *Bull. Agric. Inst. Sci. Saigon* (1921, **3**, 26). The caterpillar forms a sheath from pieces of the leaves, which are bound together with silky threads. In these sheaths, which are attached to the leaves by strands of silk, the caterpillars live and undergo their metamorphosis. The caterpillars are brownish-red in colour, and from 12 to 15 millimetres long. They may be destroyed by spraying the leaves with arsenical insecticides, preferably a little before or after the hatching of the eggs, and in any case not later than a week before the caterpillars have attained their full development. This treatment is practicable only for young coconut palms, unless powerful pumps are employed. Destruction of the chrysalides and

of the eggs may be effected by collecting and burning the attacked leaves, but this treatment has the disadvantage that useful parasites, the larvæ of which attack the caterpillars, are also destroyed. To obviate this, it is suggested that the collected leaves should be stored in wooden or masonry structures, equipped with well-fitting doors, where the moths and the parasitic flies would emerge, the latter being allowed to escape through apertures covered with perforated metal, the holes of which are sufficiently small to keep the moths inside. The leaves are burned the year after their collection. A suitable arsenical insecticide is prepared from a mixture of sodium arsenate and lead acetate. Such a spray adheres well to the leaves and does not burn them.

Ground Nuts.—Practically the whole of the groundnut crop of India is grown in the three provinces of Madras, Burma and Bombay. According to the final crop forecast published in the *Indian Trade Journal* (1921, **60**, 252), the area under this crop for the season 1920–21 is 1,951,000 acres, which is about 23 per cent. in excess of the acreage for the previous year, but equals the average for the preceding five years. From this area it is expected that 931,000 tons of ground nuts in shell will be harvested. This yield is greater by 13 per cent. than that for the previous season, but is a little less than the average yield for the preceding five years. Of the total area under cultivation, 75 per cent. is in the province of Madras, which should yield 695,000 tons of nuts, an increase of 22 per cent. above last season's yield. Burma possesses 13·5 per cent. of the total area, and should yield 118,000 tons, an increase of 16 per cent. over the crop for 1919–20. The same tonnage of ground nuts is estimated for the province of Bombay, which, although cultivating an acreage only 1 per cent. less than last year, seems likely to produce a yield smaller than that of the previous season by 22 per cent. This lower yield is due to the lack of late rains in some districts, which prevented the full development of the pods, and in other districts to the fact that the non-irrigated crop has done badly.

Rubber

Hevea

Preparation of Rubber.—*Archief voor Rubbercultuur* (1920, **4**, 397) records the results of an investigation to overcome the early coagulation of latex caused by the lime salts contained in the water used to dilute the latex. Estates situated on highly calciferous soils have been faced with

the difficulty that latex on dilution with well water, containing a high percentage of bicarbonate of lime, curdles very rapidly, necessitating the immediate and rapid handling of the collected tappings. The experiments showed that the Jewell filter using alum was not efficient in the case of these waters, but the reduction of the quantity of lime salts in the water to an insignificant amount was accomplished by adding slaked lime to the water. It is recommended that the water should be filtered after being drawn off from the subsiding tanks, either a Jewell filter or an ordinary sand filter being used for the purpose. Water purified by this treatment was found to cause practically no early coagulation, and the results are stated to have been very good in comparison with those produced by the untreated water. Estates using more or less dirty river water are advised to clarify the water by means of a Jewell filter, and then reduce the lime content with the lime treatment described above.

Latex Vessels.—In the same *Archief* (p. 473), an account is given of investigations of the anatomical structure of the system of laticiferous vessels in root and bark, and of experiments on the influence of tapping on the movement of latex. The results showed that, from the number of laticiferous vessels in the root as compared with that in the stem, the latex capacity of the roots is low, and consequently they are not worth consideration as a latex reservoir. Two types of distribution of latex vessels in the bark were distinguished. In one type the number of latex vessels was approximately the same at a considerable distance from the ground as it was at the base. In the other type the number of latex vessels rapidly decreased from the base upwards ; it is considered that trees possessing this type of structure would be inferior as latex producers. Most of the laticiferous vessels of the root and trunk are in direct connection with each other, so that a movement of latex for a certain distance is possible, but radial connections between the vessels are very infrequent. With regard to the movement of latex it was found that a direct influence is felt at one metre from the tapping cut. In view of this result it would be advisable in the case of trees attacked by brown bast disease to discontinue the practice of tapping on a still healthy surface, as the tapping has a prejudicial influence on the diseased areas. It is better to give a diseased tree complete rest. A further conclusion drawn from these experiments is that tapping with two cuts, one above the other, is inadvisable, because the latex yield of the upper cut is greatly hindered by the lower cut, and the yield is

poor in proportion to the consumption of bark. It is considered also that the exhaustion of the bark between the two cuts is also likely to lead to brown bast disease.

Fibres

Flax.—In an account of the Baltic Provinces of Russia by Boris M. Baievsky, of the Russian Division, Bureau of Foreign and Domestic Commerce, Department of Commerce, United States, which has been issued as *Supplement No.* 16*c* (December, 1920) *to Commerce Reports*, certain information has been given with regard to flax growing in these provinces (Esthonia, Livonia and Courland). During the years 1901–15 the average area planted annually with flax amounted to 236,315 acres, the average annual crop was 38,902 tons, and the average yield per acre 368 lb. The fibre is grown to the greatest extent in the Government of Livonia, but in some years the yield per acre has been larger in Courland, this being due to the fact that in Livonia flax is mostly sown by the peasants. Of the total flax crop of twenty-seven flax-growing Governments of Russia, the production of the Baltic Provinces during 1901–15 was about 9·8 per cent.

In Esthonia the sale and export of flax, tow and linseed were, until recently, a government monopoly; the flax was purchased from the producers at definite prices, according to the quality of the fibre and the rate of exchange. With the proceeds of the sale of the flax the Government bought farm machinery, which was sold to the farmers at the net price at the same rate of exchange as that at which the Government bought the flax. The export price of flax at Riga in March 1920 was £350 per ton.

Further information on the flax trade of Esthonia is given in *Commerce Reports* (1920, No. 298) where it is stated that the area planted with flax in 1919 was approximately 30,138 acres, and the yield 4,044 tons of fibre and 4,252 tons of seed. In November 1920 the Government decided to abolish the flax monopoly, and substitute for it a "flax control." Under this new scheme trade in flax is only permitted under Government licence and in accordance with official regulations. Esthonia factories requiring flax must obtain licences to purchase, and the quantity sold to each factory is fixed by the Government. Flax traders must submit detailed accounts of their transactions, and the flax control must be kept informed as to where the flax is stored. Commercial flax must be marked "Esthonia flax" in Esthonian and English. An export duty of 30 per cent. has been imposed.

Esthonia flax is not of the highest grade, but some of it

is of good quality. It is described as long, soft, of a very light colour and capable of being manufactured into goods of a fine quality.

It is stated in *Commerce Reports* (1921, No. 32, p. 768) that flax cultivation has been gradually increasing in Finland since the outbreak of the war, and that the crop is of great importance to the local linen industry owing to the difficulty of obtaining supplies of flax from abroad. Great efforts have been made by the agricultural societies to encourage the farmers to extend the cultivation. The best results have been obtained in Central Finland, where flax growing has been carried on for the longest time; in 1920 the average yield amounted to over 1·2 tons of rippled straw per acre, whilst one cultivator obtained as much as 2·7 tons per acre. In Southern Finland the 1920 crop suffered somewhat from the drought which prevailed, but gave an average yield of nearly 1·1 tons of rippled straw per acre. These results are regarded as very satisfactory in view of the fact that the cultivators are not experienced in growing flax. It is suggested that the crops could be increased by the judicious use of artificial manures.

New Zealand Hemp (*Phormium tenax*).—The *New Zealand Journal of Science and Technology* (1920, **3**, 190) contains a report by L. Cockayne, Ph.D., F.R.S., on the yellow-leaf disease of Phormium plants. Observations have been made over a period of fourteen months in the Phormium areas of Miranui and Ashlea, and the results have led to the opinion that the disease is infectious, and is due to fungoid or bacterial attack, and that its activity would be reduced if the swamps were better drained in winter, and kept wetter in summer. The disease diminishes in severity in autumn and winter, but increases in spring and summer, and is at its worst in the last-mentioned season. It has been observed that a large proportion of healthy plants remain healthy even when growing in close proximity to diseased plants; that a plant may be healthy in one part while dying off in another part and that such plants may yield good fibre; and that diseased plants frequently recover completely. Sometimes a plant may undergo great changes in the course of a year, disease being followed by recovery, recovery by disease, and so on. Even during the worst period of the disease it was noticed that more healthy plants remained healthy than became diseased, that a large percentage of healthy plants remained healthy continuously, and that very few plants died outright. A mild attack of the disease may be beneficial, as the removal of a few leaves leads to better development of the remainder. Among other results of this study, it

was found that there appear to be some plants which are resistant to yellow-leaf disease and might be used for the selection and establishment of an immune race.

Cotton

Pink Boll-worm.—Reference to the presence of the pink boll-worm (*Pectinophora gossypiella*) in Texas and Louisiana and to the efforts which are being made to restrict the area of infestation has been made in this BULLETIN (1920, **18**, 297). In both States, laws have recently been enacted to effect the control and eradication of the pest, and these have been printed in *Service and Regulatory Announcements* (*Fed. Hort. Bd.* 68) *U.S. Dept. Agric.*, issued October 22, 1920. Control work under the authority of this new legislation is now being organised on a co-operative basis by the Federal Horticultural Board of the Department of Agriculture.

It is noteworthy that Section 1 of the Texas Act states that "the pink boll-worm is recognised as a destructive pest of cotton, is hereby declared a public nuisance and a menace to the cotton industry, and its eradication is a public necessity." The Act provides (1) for the creation of a zone along the boundary between Texas and Mexico, and for the inspection of cotton fields in this zone; (2) for emergency quarantine of cotton or cotton products infested with the pest and for the disinfection of such products; (3) for the supervision of areas contaminated or infested but in which it is not deemed necessary to destroy the cotton or the cotton fields; (4) for condemnation, destruction and compensation in respect of cotton fields infested or of cotton or cotton products found to be infested; (5) for the creation by proclamation of the Governor of zones in which cotton may be grown under regulations and of zones in which cotton growing may be declared a public menace and the production prohibited; (6) for the Commissioner of Agriculture to promulgate rules to give effect to the provisions of the Act; (7) for the issue of special or emergency quarantines by the Governor; (8) for the appointment of a pink boll-worm commission; (9) for the appointment of a compensation claim board in the event of the establishment of non-cotton zones; (10) for co-operation between the Commissioner of Agriculture and the Secretary of the United States Department of Agriculture; (11) and for the compensation of persons who may sustain loss through the operation of the Act. The Act also declares the policy of the State in its efforts to control and eradicate the pink boll-worm, provides penalties for the violation of its provisions, and provides for the appropria-

tion of $100,000 to carry it out, $50,000 of which is for administrative expenses and $50,000 for paying compensation to farmers.

While welcoming the Act as probably the best legislation obtainable in Texas at the time of its enactment, the Department of Agriculture points out certain weaknesses which it is hoped will be rectified in the next regular session of the Texas Legislature. These relate chiefly to the regulations for the establishment of non-cotton zones and the destruction of cotton in infested fields.

The Louisiana Act creates a commission for the purpose of enforcing the order of the Commissioner of Agriculture of that State establishing non-cotton and regulated zones, and appropriates $250,000 for that purpose and for the compensation of planters. It gives ample authority for the carrying out of any necessary control work designed for the ultimate extermination of the pest. A Supplemental Act provides for the imposition of a licence tax on the cotton industry of the State to provide revenue for the suppression of the pink boll-worm.

Paper-making Materials

Papyrus.—Considerable attention has been given at the Imperial Institute to the possibilities of papyrus as a paper-making material, and reports have been published on the investigation of the stems from the Sudan, East Africa Protectorate (Kenya Colony), Zululand, and Egypt (this BULLETIN, 1912, **10**, 372; 1916, **14**, 165; 1919, **17**, 154).

Experiments on the treatment of papyrus have now been carried out at the École française de Papeterie and an account of the results has been given by L. Vidal and M. Aribert in *L'Agronomie Coloniale* (1921, **6**, 1, 53).

The experiments were made with papyrus stems from the Gaboon. The air-dry stems contained 15 per cent. of moisture, and yielded 47 per cent. of cellulose (determined by the chlorination method), 2 per cent. of ash, 3·4 per cent. of fatty substances, and 4·3 per cent. of matter soluble in water.

The stems were cut into pieces about 2 inches long. A study was made of the effect of maceration in cold solution of caustic soda, but the results showed that it was not possible to obtain a satisfactory pulp by this means, but that the product was only partially freed from encrusting matter and was hard and unbleachable. It is considered, however, that better results might possibly be obtainable with the fresh stems in the place of origin.

Trials were then made by the ordinary method of

digestion with hot caustic soda solution. It was found that, if the papyrus is submitted to the action of steam before treatment with the alkali, the digestion can be carried out with 13 per cent. of soda instead of 15 per cent. and that the pulp can be bleached with 21 per cent. of bleaching powder instead of 24 per cent. The treatment with steam would, however, probably be unnecessary when dealing with the freshly cut stems.

The following method is suggested for the manufacture of papyrus pulp on an industrial scale. The papyrus, in pieces about 2 inches long, is introduced into a spherical rotatory digester, where it is first treated with steam under a pressure of 1–2 atmospheres, and subsequently heated for 6½ hours with 13 per cent. of caustic soda (calculated on the weight of the moisture-free papyrus) of concentration 6° Baumé and under a pressure of about 3½ atmospheres. The pulp, after washing, is of a pale brown colour; the yield amounts to about 40 per cent. of the weight of the dry raw material. The pulp resembles that of esparto grass and is easily bleached, the yield of bleached pulp being 34 per cent.

Paper made from the pure papyrus pulp was of very good quality, and the results of mechanical tests showed that it was of satisfactory tenacity.

A detailed account is given of the microscopical characters of the pulp, which shows that it is composed mainly of fibres, the non-fibrous elements (parenchyma, vessels, etc.) amounting only to about 10 per cent. of the bleached product. It is pointed out that papyrus pulp can be readily identified by the presence of characteristic star-shaped cells with three projections.

The final section of the paper discusses different methods of organising the exploitation of the Gaboon papyrus. The exportation of the raw material is dismissed as impracticable, because transport would be too costly and also because it would necessitate the treatment of the papyrus in the dried state. The manufacture of wrapping paper could perhaps be carried out on the spot by simple maceration with lime in open vessels. In this manner a coarse, coloured pulp could be obtained which would furnish a packing paper similar to a rough straw paper. The best method of utilising the papyrus, however, would be the manufacture by the soda process of unbleached pulp for export. This could be undertaken in the papyrus areas, and would probably be greatly facilitated by the employment of the freshly cut material, which would be whiter and more tender than the dried stems used in the experimental trials.

FORESTRY AND FOREST PRODUCTS

Forestry in British Guiana.—A useful summary of information as to the work of the Forestry Department, British Guiana, was prepared for the British Empire Forestry Conference of July, 1920, by Mr. L. S. Hohenkerk, the Forestry Officer. It opens with a general description of the country, which deals, *inter alia*, with the soils, including the mountain sandstones, the thick marine alluvium of the coast and the laterite and other residual deposits of the river-valleys; and with the climate, with its almost constant north-east trade wind, high rainfall (upwards of 91 inches), and decennially recurrent droughts. The description of the forests which follows is summarised from a Government Report published in 1912. Its most practically interesting feature is, perhaps, the explanation that the forests, though mixed, contain species that, though not strictly gregarious, are locally predominant, mora, for instance, constituting on an average 29½ per cent. of the trees in some situations, greenheart over 21 per cent. in others, and wallaba (*Eperua*), which is largely used for shingles and staves, as much as 34 per cent. in others. The forests of British Guiana, though never yet accurately surveyed, are estimated to cover over 78,000 square miles, or nearly 88 per cent. of the entire country, and the value of the balata, charcoal, fuel, shingles and tan barks obtained from them is considerably in excess of that of the timber. No estimate can be made of the stand of timber, of the rate of increment or of the loss by fire and waste, though it has been observed—as might have been expected—that the rapid growth of tropical vegetation soon reafforests devastated places with soft and often less valuable woods. Mr. Hohenkerk has recast and enlarged the descriptive list of uiana timbers which he contributed to *Timehri* in 1917, and to the *Journal of the Board of Agriculture of British Guiana* in 1919. In so doing he makes full acknowledgment of his indebtedness to the investigations and publications of the Imperial Institute. It is not very creditable to those who should have the commercial interests of our colonies at heart that so many of these woods are as yet undetermined or imperfectly known. The writer points out that, in addition to the detailed study of natural reafforestation and rate of increment, frequent inspection of the greenheart and other forests now under exploitation is necessary in order to check waste, secure the preservation of parent trees and minimise damage by fire; but that for such purposes the present staff of one officer, one native assistant

and seven untrained native rangers is obviously wholly inadequate. Among his practical suggestions is the establishment of modern saw-mills near navigable rivers with a drying kiln attached to each of them; and he also suggests a forest laboratory for testing forest products both chemically and physically.

Patagonian Forests.—A report entitled *Los Bosques Patagonicos*, by Max Rothkugel, published by the Argentine Ministry of Agriculture in 1916, is summarised in the *Geographical Review* for January 1921 (p. 141). The temperate rain-forest of Schimper extends west of the axis of the Andes from 38° S. to 48° S.; has a rainfall of 80–120 inches, and contains the evergreen beeches roble (*Nothofagus obliqua*), rauli (*N. procera*), and coihue (*N. Dombeyi*), and the coniferous cipres (*Libocedrus chilensis*), alerce (*Fitzroya patagonica*), *Podocarpus* and *Saxegothea*. The colder rain-forest with few species extends from 48° S. to Cape Horn, and is characterised by *Nothofagus betuloides*, the wood of which, also known in Chile as "roble," has been largely used there for panelling in railway-carriages. Pure forests, chiefly of lengue (*N. pumila*) and ñire (*N. antarctica*), lie to the east of the rain-forests from near Neuquen (lat. 38° S.) to Tierra del Fuego at altitudes of 4,000 to 6,000 ft. in the north and from sea-level to 2,000 ft. in the south. Pure forests of the Chilean pine (*Araucaria imbricata*), the familiar "monkey-puzzle," which are as yet very inaccessible, cover some 200,000 acres in Argentina from altitudes of 2,100 ft. above sea-level at 40° S. to about 6,000 ft. at 37° S. The strictly Patagonian area of forest in Argentine territory occupies nearly 10,000 square miles, but its only present value is as a protection to the water-supply of the irrigable land at lower levels.

Tree Surgery.—The United States Department of Agriculture has issued a concise practical bulletin (*Farmers' Bulletin*, 1178, 1920) by J. F. Collins on tree surgery. It will, as this publication points out, seldom be commercially profitable to apply the more elaborate processes of tree-repair to mere timber trees; but, where the preservation of individual specimens is desirable from æsthetic considerations, it is important that effective methods should be employed. The economy of prompt treatment is rightly insisted upon, and the principles underlying the work, such as the necessity of protecting the cambium from injury, are clearly explained. The proper method of removing limbs, and the necessity of at once rendering every wound antiseptic, are described, the use of climbing spurs, or even

of nailed or hard-soled boots by workmen, being deprecated. All decaying parts must, it is shown, be thoroughly removed before a cavity is filled and all cut surfaces of sapwood, cambium or bark should be coated with shellac within five minutes of being cut. The use of bolts or guys is described; but it is somewhat surprising that the practice of filling large cavities with strips of wood instead of asphalt or cement is explained without any suggestion of its generally unsatisfactory character.

"Sycamore."—Under the title of *Utilization of Sycamore* the same Department has issued a bulletin (No. 884, 1920) by W. D. Brush on the uses of the wood of *Platanus occidentalis*, the American plane, to which the name "sycamore" is not commonly applied in this country. As is so generally the case with products of secondary importance, the demand is restricted by the inconstancy of the supply, and this wood, which is particularly fitted for barrels and packing boxes for tobacco because it does not impart stain, taste or smell to materials packed in it, is often replaced by the less suitable red gum (*Liquidambar*). When quarter-sawn, the plane wood—then sometimes known as lace-wood or honeysuckle-wood—has a pleasing appearance, its silver-grain being, unlike that of oak, darker than the rest of the wood. It makes an inexpensive veneer or panel wood.

Black Walnut.—The same Department has recently issued two bulletins dealing with the American Black Walnut (*Juglans nigra*), one (*Bulletin* No. 909, 1921) on its utilisation, by W. D. Brush; the other (*Bulletin* No. 933, 1921), by F. S. Baker, on its growth and management. In former times much of this valuable wood was wasted in clearing or cut for fuel and for fence-rails; and the American Civil War created the first large demand for it for gunstocks, though its popularity for furniture began somewhat earlier. The maximum cut was 125 million board-feet in 1875; but with the great European demand for it of late for aeroplane-propellers and rifle-stocks this figure has again been nearly reached. Though the tree belongs mainly to the eastern United States, the best wood in the past coming from Ohio and Indiana, the largest stands are now west of the Mississippi. Walnut wood is especially valuable on account of its stiffness, smooth and unsplintering finish and good glueing quality, figured wood, especially that from root-burls, being so precious that it is usually cut into veneers one twenty-eighth of an inch in thickness. Mr. Baker estimates the existing stand of black walnut at 821,000,000 board-feet,

the larger half of which is in the South Central and South Atlantic States. The tree should reach 82 feet in height in 100 years, with a diameter of 25 in. and an average volume of 320 board-feet, increasing to over 500 board-feet at 130 years and to 635 at 150 years. It requires deep, fertile, moist but well-drained soil, so that its planting cannot yield the same return as agricultural crops. It is impossible to obtain a maximum yield of walnuts and of wood at the same time, the former demanding wide spacing and the latter close planting.

Dry-rot in Incense Cedar.—Like the deciduous cypress (*Taxodium distichum*), the incense cedar of California and the Pacific slope (*Libocedrus decurrens*) ranks only as a second-class timber species, because so large a percentage of the standing trees are affected by dry-rot or peckiness. The latter tree is not very abundant, never occurring in pure forest, and only averaging 8 per cent. of the mixed stand in which it is found. When sound, its wood has been much used for fencing, shingles and sleepers, and, of late, as a substitute for pencil cedar (*Juniperus virginiana*); but the standing timber fetches a low price, and the total amount cut annually is comparatively small, because of the large percentage—estimated at from 30 to 50—of worthless trees. Though the tree is attacked by a mistletoe and by several minor fungi, and several fungi attack and destroy the felled or fallen timber, the main damage to the living trees is caused, as shown in a recent memoir by J. S. Boyce (*Bulletin* No. 871, 1920, *U.S.Dept. Agric.*), by *Polyporus amarus*. The effects on the wood closely resemble those produced in the Taxodium by the allied fungus *Fomes geotropus*, which is by no means confined to the cypress, but occurs also on tupelo, *Liquidambar*, *Magnolia*, elm and maple. As the *Polyporus* attacks the heart-wood, the trees are not infected until wounded, and it is found that fire is responsible for 84 per cent. and knots for 10 per cent. of the cases of infection, lightning and frost causing part of the remainder. Improved protection against forest fires is, therefore, the obvious means of raising the average value of incense-cedar trees.

MINERALS

General

Minerals of Westmoreland.—According to the *Iron and Coal Trades Review* of Feb. 11, 1921, Vincent Bramall recently read a paper before the Manchester Geol. and Min. Soc., entitled, "A few Notes on the Minerals found in

the Neighbourhood of Appleby, Westmoreland, and more particularly on the Mining, Manufacture and Uses of Barytes." In this paper are described eight veins in which lead minerals and barytes are associated; a large body of hæmatite ore containing about 42 per cent. of iron; and also a bed of pyrolusite.

Non-metallic Mineral Deposits of Manitoba.—In the *Bull. Canadian Inst. of Min. and Met.*, Jan. 1921, D. C. McArthur describes a few of the important deposits of a non-metallic character found in Manitoba. These include a Portland cement limestone; an argillaceous limestone which forms a natural cement on burning; gypsum; stone suitable for building, chiefly of the limestone variety; red granite, of which quarries have been opened seventy-five miles east of Winnipeg; limestones suitable for producing industrial lime; brick-earths of good quality; orthoclase felspar; phosphatic shale, and rock-salt; whilst samples of talc and muscovite mica have been collected in the Nelson River district.

Alkali Deposits of Western Canada.—Under this title is issued No. 1 of a "Memorandum Series" by the *Canada Dept. of Mines, Mines Branch.* Soluble mineral salts are known in the provinces of Manitoba, Saskatchewan, Alberta and British Columbia, either in the form of bedded deposits or as brines. These are of two types: (1) solid salts and brines in undrained or partially drained basins; (2) brines of streams or springs. These deposits have not yielded any large quantity of salts, but during the year ended March 31, 1920, Epsom salts to the amount of 1,523 cwts. and valued at $893 was exported from the natural deposits in British Columbia.

Non-metallic Mineral Industries of the United States.—In the *Eng. Min. Journ.* for Jan. 29, 1921, Raymond B. Ladoo discusses the production of inorganic non-metallic products in the United States, which has reached an annual value of upwards of £100,000,000. Over thirty of the more important non-metallic products are described, as well as many of their uses.

Geology and Ore Deposits of Utah.—Some years ago the Geological Survey of the United States conceived the idea of publishing a series of volumes as *Professional Papers* in each of which should be described the geology and ore deposits of a single State. The first of the series, dealing with the ore deposits of New Mexico, was published in 1910 (*Prof. Paper*, 68). A second volume describing the Geology

and Ore Deposits of Utah has recently been issued (*Prof. Paper*, 111, 1920). The latter is a work of 672 pages, illustrated by 57 plates, diagrams and geological sections, and embodies the work of B. S. Butler, G. F. Loughlin, V. C. Heikes and others.

The results of previous investigations are summarised and correlated, and districts not elsewhere described geologically have been specially surveyed, with a view to making the volume as complete as possible.

South American Mining Fields and Practice.—In the *Eng. and Min. Journ.* of March 26, 1921, H. Staver describes certain mineral deposits of Brazil, more particularly those of iron and manganese ores, and also the chromite deposits of Bahia, from which 30,000 tons of ore have been mined in recent years. Some petroleum and oil shales are found in Brazil, but, apart from the deposits referred to, economic minerals are not abundant.

Economic Minerals of Madagascar.—In the *Eng. and Min. Journ.* of Jan. 1, 1921, is an interesting account by Geo. F. Kunz of Prof. A. Lacroix' investigations of the mineral deposits of Madagascar, which include ores of gold, precious stones, graphite, corundum and radioactive minerals. The graphite is of excellent quality, and production in 1917 reached 35,000 tons. The exports of corundum vary, but in 1919 amounted to 812 tons. The radio-active minerals include autunite, fergusonite, samarskite and euxenites, and small quantities of thorium are also found associated with these. The quantity of these minerals exported annually has been upwards of 8,000 kilos. Zircon is also found in relative abundance.

The Mineral Resources of Yunnan, South China.—A memoir by J. Coggin Brown on the mines and mineral resources of Yunnan has been published recently by the Indian Government (*Mem. Geol. Survey of India*, 1920, **47**, pt. i), and the same author has also contributed an article on the subject to the *Mining Mag.* of November and December, 1920. This Chinese province lies immediately to the east of Burma, and, if India and China are ever to be connected by a railway, the line would have to pass through Yunnan, and its mineral resources must therefore be of importance to our Indian Empire. The minerals occurring in the district include sulphide of arsenic (orpiment), coal, ores of copper, iron, lead and silver, and common salt. Notes on these will be found under their respective headings in the following pages of this BULLETIN.

Alunite

United States.—In the *Eng. and Min. Journ.*, Jan. 29, 1921, J. G. Braun describes a deposit of alunite about thirty miles from San Antonio, South Central Texas, in what appears to be a decomposed trachyte. There are three outcrops and, although the size of the deposit has not been proved, there is apparently a large amount of the material present. Analyses of samples show the alunite to be of good grade, containing about 11 per cent. of potash and 34 to 35 per cent. of alumina.

Arsenic

Canada.—D. Cushing describes, in the *Canadian Min. Journ.* (March 11, 1921, p. 196), a mineralised area at Howry Creek, situated about sixty-four miles from Sudbury, Ontario. Geologically, the country is said to resemble the Kirkland Lake district, and the predominating rocks are greywacke, conglomerates and porphyries. The minerals so far found in commercial proportions are gold, silver, platinum and arsenic, the last being present in the ore up to 24 per cent. One vein, exposed at the surface for a length of 2,700 ft., is from 3 to 5 ft. in thickness. It is reported that the Howry Creek Co. propose to treat the ore in the first place for arsenic, and to recover the gold, silver and platinum from the residues.

China.—Orpiment, the tri-sulphide of arsenic (As_2S_3), has been imported into Burma from Yunnan for a considerable number of years (*Mem. Geol. Survey, India*, 1920, **47**, 145). The importation in fifteen years amounted to 5,675 tons, which gives an average of 378 tons per annum. J. Coggin Brown was the first European allowed to examine the deposits. The mines lie at the head of a narrow ravine, at an altitude of 8,100 feet. The rock in the immediate vicinity of the mines consists of quartzitic sandstones and shales, striking N.N.W. to S.S.E., and dipping at high angles E.N.E. The mineral is being won by seven inclined drives or shafts from 600 to 1,000 feet in length, well timbered, and with steps to facilitate ascent and descent. At every 100 feet they are driven horizontally for 8 or 10 feet, where sumps are dug into which the water drains. There are ventilation shafts to the surface at various points. The ore occurs in the bedding, joint and fracture planes of shattered greyish quartzite for a thickness of 4 feet. The orpiment, occurring in places with soft blackish shales, is associated with small quantities of realgar ($As\,S$) and minute cubes of pyrite. The arsenic sulphides are seen to

be irregular stringers, swelling out into patches and bands, which sometimes attain a thickness of over 12 inches; the larger lumps, however, only persist for short distances. All mining work is done with hammer and chisel, the broken ore being carried to the surface in baskets by boys; it is then cracked by hand, and the richer portions are picked out. Those pieces which cannot be so treated are roughly crushed, and the gangue is separated by panning in small closely-woven bamboo baskets. This method causes a great waste of the finer disseminated ore.

Chromite

Brazil.—H. E. Williams in *Eng. and Min. Journ.* (Feb. 26, 1921) describes the chromite deposits of Brazil which in recent years have yielded several thousands of tons of ore for shipment to the United States. These deposits are at Santa Luzia in the State of Bahia and the ore is found as lenses in a fine-grained gneiss, which is cut by numerous pegmatite dykes. Massive chromite elsewhere exists almost invariably in pyroxene rocks or their serpentine derivatives, and the presence of the chromite lenses at Santa Luzia in gneiss appears to be unique.

Coal

United Kingdom.—Grenville A. J. Cole, in an appendix to the *Report of the Irish Coal Industry Committee*, recently published, gives a new estimate of the probable coal reserves in the Irish coal-fields. It is based on the estimate which appears in *Coal Resources of the World*, 1913, but with important modifications: for instance, the reserves of Ballycastle are much increased, whereas those of Leinster are reduced by as much as 80,000,000 tons, owing to the lack of continuity of the No. 2 coal throughout the basin. The new estimate of Irish Reserves (actual and probable) amounts to about 222,000,000 long tons, as compared with about 286,500,000 long tons given in vol. ii of the *Coal Resources of the World*.

A paper by H. H. Ridsdale on the "Geological Relationship of the South Staffordshire, Warwickshire, South Derbyshire and Leicestershire Coal-fields" was read on Jan. 3, 1921, before the S. Staff. and Warw. Inst. Min. Eng. (*Abst. Colliery Guardian*, Jan. 7, 1921, p. 38). With regard to the possible extension of the coal-fields, Ridsdale concludes (1) that the ground to the west of the Warwickshire Western Boundary fault and the Linton fault is so uncertain that it is very unlikely to be workable at a profit; (2) that the unproved area in the South Derbyshire basin is a likely area for further mining enter-

prise, but the depths to the coals and the risks from water-bearing strata overlying them are contingencies which would require great engineering skill to overcome; and (3) that the coals in the unproved area in the Leicestershire basin will be so disturbed by faults and igneous intrusions, and of so inferior a quality, that it will be an unprofitable area to develop until the now visible coal-fields are more nearly exhausted.

China.—According to J. Coggin Brown (*Mem. Geol. Survey, India*, 1920, **47**, 60), true Triassic and Mesozoic (Carboniferous) coals occur in Yunnan, but it is impossible at present to arrive at any definite estimate of the amount of fuel available. All that can be said is that the coal-fields already known are likely to contain large quantities of coal. This coal is used locally, and may supply the fuel for future railways, but, outside the frontiers, it is doubtful whether it will ever be able to compete successfully with foreign coals.

Distribution of Mineral Matter in Coal.—Under this title a paper by R. Lessing was read on Jan. 22, 1921, before the Midland Inst. Min., Civil and Mech. Eng. (*Abst. Iron and Coal Trades Review*, Jan. 28, 1921, p. 129). In previous investigations by Lessing, Tideswell, Wheeler and Marie C. Stopes, it was shown that the percentage of ash in *clarain* (bright coal with plant débris) and in *vitrain* (apparently structureless bright coal with conchoidal fracture) is fairly constant, but is much more varied in *durain* (dull hard coal), and exhibits very considerable discrepancies in different samples of *fusain* ("mother-of-coal"). Lessing proves the insufficiency of information obtained from the customary ash test performed in ordinary coal analysis. He considers that a detailed study of the dirt constituents is absolutely essential if the methods of coal washing are to be improved and the recovery of such by-products as pyrite is to become general, and that the influence of the proximate and ultimate composition of ash is of the utmost importance when coal is burnt in gas-producers, as well as in coal-dust firing and when coal in a finely divided state is used in association with petroleum as "liquid" or "colloidal" fuel.

Copper

Union of South Africa.—According to a recent publication of the *South African Geol. Survey* ("The Economic Geology of Pondoland," by G. L. du Toit, 1920), ores of copper and nickel (chalcopyrite and pentlandite with pyrrhotite) are found in the Insizwa Range disseminated

through the basal portion of gabbro in a number of localities along the contact with hornstone. The sulphides form veins and lenses of considerable richness in places, but the actual ore-body, if worked, would be a gabbro-picrite containing from 5 to 6 per cent. of sulphides. Assays show the percentage of nickel to be a little less than that of the copper, but the commercial value of the former is about twice that of the latter. There are accessory amounts of platinum and gold. The ores are low in grade, but appear to be considerable in quantity. The deposits are favourably situated for mining, and the metallurgical extraction should not prove difficult.

Canada.—A paper by R. C. Wallace on the "Flin-Flon Ore-Body" (of Manitoba-Saskatchewan) is printed in *Bulletin* 106, *Canadian Inst. Min. and Met.* (Feb. 1921, p. 106). The ore-body lies in amygdaloidal greenstones, associated with lamprophyric dykes and quartz porphyries. A later intrusion of granite is found one mile south-west of the ore-body. The Flin-Flon and other sulphide deposits, as well as the gold-bearing quartz veins of the region, are to be referred to this granite as ore deposits representing deposition at lower and higher temperatures respectively. The ore-body strikes with the country N. 36° W. and dips E. 70°, and appears to pitch at a low angle to the south. It has a known length of 2,593 ft. At a depth of 900 ft., it has been proved for 1,000 ft. The greatest width is 400 ft., but it is only 35 ft. wide at the 900-foot level. From diamond drilling and underground development work the reserves are estimated at 16,000,000 tons. The deposit is composed of pyrite, blende and chalcopyrite ; gold and silver are apparently associated with the pyrite. Solid sulphides occur in the centre and towards the hanging-wall, and disseminated ore on the foot-wall, and usually a selvage of disseminated ore separates the solid sulphides from the hanging-wall. The hanging-wall carries less chalcopyrite and more pyrite, and therefore more gold and silver, than the foot-wall. The foot-wall assays from 3 to 5 per cent. of copper. Taking the deposit as a whole, the average of copper is 1·9 per cent. and that of zinc 3·8 per cent. The ore-body has been formed by replacement, with which silica has, to some extent at least, been associated.

Spain.—An article on cupriferous pyrite in the Huelva District, Spain, by Courtenay de Kalb appears in the *Mining and Scientific Press* (Jan. 22, 1921, p. 125). De Kalb states that the total quantity of ores mined and stocked in the leach-beds in the province of Huelva ap-

pears to be not less than 25,000,000 tons, of which about 18,500,000 tons belong to the Rio Tinto Company. The total ore in sight, actually developed and ready for extraction, will apparently exceed 230,000,000 tons, of which 56,000,000 tons are in Rio Tinto alone.

The pyrite zone is 120 miles long from east to west (viz. 30 miles in Sevilla, 50 miles in Huelva and 40 miles in Portugal), and 25 miles wide from north to south. A number of diabase dykes, coursing N. 70° W., are in the slate country, which is of Silurian and sub-Carboniferous ages. The copper for the most part follows the parting-planes in the pyritic masses, and is present in a coating of chalcocite, mostly of the sooty variety, and in films of chalcopyrite. At the Rio Tinto mine, about three-fourths of the copper present is secondary, persisting to the lowest level of the San Dionysio mine (the 32nd), or over 1,200 ft. below the surface. The normal average is 2 per cent. of copper. It is customary to assume that the primary ore contained from 0·3 to 0·6 per cent. of copper.

China.—J. Coggin Brown (*Mem. Geol. Survey, India*, 1920, **47**, 123) states that copper ores are widely distributed throughout Yunnan, and, at one time, copper mining was the most important branch of the mineral industry of the province. The decline of the last fifty years is due to a number of causes, the chief being: (1) partial exhaustion of rich surface ore; (2) political disturbances, too rigid Government interference, etc.; (3) destruction of the forests and consequent rise in the price of charcoal; (4) difficulties of transport. Some of the larger deposits in certain districts merit careful individual attention. The future expansion of copper mining and smelting will depend on the scientific application of the most recent practice; but, for this, better transport facilities and a generous attitude by the Administration are essential. The Tienpao mine in 1893 is believed to have found employment for 1,000 men, and to have produced 300 metric tons of copper per annum (*Mining Mag.*, 1920, **23**, 274). There are three interstratified ore bands with sandstone floors and shale roofs. The ore occurs in the form of balls rich in copper carbonate. The occurrence reminds one of that at El Boleo mine, Santa Rosalia, Lower California, Mexico, where three interstratified beds are found in volcanic tuffs and conglomerates containing balls (*boleos*) of copper carbonate and other copper oxides.

Corundum

Union of South Africa.—A comprehensive description by A. L. Hall of the Transvaal corundum deposits, which

are said to be the largest and most important yet discovered, is given in *Geol. Survey Mem.* 15, 1920, *Dept. Mines and Indust., Un. of S. Africa.* The corundum occurs in the plateau region served by the Messina railway, and in the low country served by the Selati railway. Granitic and gneissic rocks constitute the chief formations, included in which are numerous relatively small masses of basic magnesian rocks, in which the corundum occurs. It is concluded, from the geological relationships, that the corundum has originated from an excess of alumina occasioned by some of the silica in pegmatites of granitic origin being abstracted by the basic rocks into which they have been intruded. Instances are noted where an intrusive granite shows quartz and felspar at the centre, felspar only in the next zone, and, in the outside zone, where a further absorption of silica has taken place, felspar associated with corundum.

Fluorspar

United States.—In *Eng. and Min. Journ.*, Jan. 29, 1921, J. M. Blaney describes the mining, milling and occurrences of fluorspar in Illinois. It is shown that nearly all the fluorspar found in the United States is in fissure veins, and that the largest deposit yet discovered, known as the "Fairview Rosiclaire" vein, situated in Hardin Co., Illinois, occurs in a true fissure. The fluorspar is usually associated with calcite, and carries a small percentage of zinc and lead minerals.

Gold

Rhodesia.—Some of the auriferous deposits of Southern Rhodesia are of great interest from a technical point of view, and the following notes are taken mainly from a recently published report by H. B. Maufe ("The Geology of the Enterprise Mineral Belt," *Bull.* No 7, 1920, *Southern Rhodesia Geol. Survey*). The reefs or lodes, generally known as "schist reefs," are replacement deposits, being impregnations of belts or zones of rock by sulphides or sulph-arsenides, sometimes accompanied by silicification.

The country rock is epidiorite (a kind of greenstone), and the reefs are closely associated with felsite, forming a succession of small, irregular, lens-shaped bodies, striking nearly E.W., and dipping north, considered to be of intrusive origin. Strictly speaking, the reefs have no walls, but there may be a strong joint or fissure on one or each side of the impregnated rock, and sometimes quartz has been deposited as a stringer or a succession of thin lenses along the main fissure.

The Arcturus mine forms a group of three reefs—Arcturus, Slate and Planet—all of which are developed on the above-mentioned replacement deposits (" schist reefs "). The Arcturus reef strikes nearly E.W., and dips N. 56°. The shoot is 600 ft. long. The Slate reef lies a little to the west of the Arcturus, and a little south of the prolongation of that reef, but the two mines are connected on the second and fifth levels, and are being worked as if they were two shoots on a single reef. The dip in the Slate mine is N. 75°. The Arcturus reef appears to have no pitch, but the Slate reef pitches towards the last at such an angle that the shoots may be expected to merge on the tenth level. The Arcturus ore has three components: (1) thin quartz lenticles, sometimes expanded to 9 ft. in width generally deposited in a fissure, but probably due to the silicification of the felsite—this component occurs only in very small quantity; (2) impregnation or replacement of epidiorite; and (3) impregnation or replacement of felsite. When mineralised, the felsite contains finely disseminated sulphides, frequently arsenopyrite, but usually pyrite. The conspicuous sulphide in the mineralised epidiorite is arsenopyrite.

The lenticles of felsite in the Slate mine are frequently coarser-grained than in the Arcturus, and pass into micro-granite.

In the Planet mine there appear to be three lenticles of felsite striking 10° S. of E., and dipping N.

According to the *South African Min. and Eng. Journ.; Rhodesian Special Number*, Dec. 1920, p. 705, the ore reserves of the Slate and Arcturus mines in October 1918 were 320,000 tons, with 12·2 dwts. gold per ton. A new four-compartment main hoisting and development shaft from which to work both mines from a central point has been started. The mill and reduction plant has a capacity of 6,000 tons per month.

Canada.—For accounts of auriferous deposits at Howry Creek, Northern Ontario, and in the Portland Canal District, British Columbia, respectively, see under " Arsenic " (p. 89) and " Silver " (p. 106).

Australia.—A report, by Lionel C. Ball, Government Geologist, on the occurrence of gold at Mount Quamby, appears in the *Queensland Gov. Min. Journ.* (Jan. 1921, p. 8). Mount Quamby, the mass of which is composed of conglomerate, lies seven miles west of Quamby railway station, which is twenty-eight miles north of Cloncurry. In 1908, G. R. Gulliver discovered gold in the gullies leading from Mount Quamby. Several of these were

worked for alluvial gold, which was ultimately traced up the gullies to the conglomerate. Most of the copper deposits in the neighbourhood are unusually rich in gold, which may perhaps be ascribed to the intrusion of granite. The gold found in the newer conglomerate is probably due to mechanical concentration by the action of moving water. The conglomerate occurs in the Cloncurry Series of schists, slates, quartzites and limestones (provisionally classed as Silurian)—rocks which are mostly highly metamorphosed. The conglomerate is made up of perfectly waterworn pebbles and boulders of quartz, lydian-stone, and less indurated slate, set in a finer-grained matrix containing a varied, but often pronounced, proportion of well-rounded pebbles and grains of massive hæmatite, with small masses of greenish mica and flakes of gold (rare). The belt strikes N.E., and the dip of the rocks is N.W. or (locally) N.E. up to 45°. The conglomerate is not interbedded in the Cloncurry Series, but its beds appear to have been thrown into a succession of moderate undulations as though compressed by force acting from the south-east and the north-west, and apparently occupy a zone of subsidence. The conglomerate is made up of rock fragments derived from the Cloncurry Series, and therefore must be younger than the latter. It has been down-faulted into the schists.

The average yield of thirty-nine samples taken from the worked ground amounted to 10 dwts. of gold per ton. But the distribution of the gold is very erratic, and the gold-content of the samples taken ranged from a trace to 50 dwts. per ton, and " the true average value of the auriferous ground cannot be arrived at with any degree of certainty until the costeans [pits and trenches] have been lengthened and deepened, and it may be not until there are underground cross-cuts either from shafts or adits."

China.—According to J. Coggin Brown (*Mining Mag.*, 1920, **23**, 336), deposits of alluvial gold, as well as gold-bearing lodes, exist in Yunnan, which deserve careful testing.

United States.—Henry F. Ferguson contributes an article on " The Limestone Ores of Manhattan, Nevada," to *Econ. Geology* (1921, **16**, 1). The ores of the Manhattan district are found in veins and as replacement deposits in limestone. The former present no unusual features, but the latter offer interesting problems. The productive mineralisation is confined to the upper of three limestone beds of Cambrian age. The principal mine, known as White Caps, has been worked to a depth of 800 feet.

The limestone is cut by three major faults, striking N.E. and dipping S.E., and by a number of small northerly faults of small horizontal displacement. The areas in which the small faults are most numerous appear to be the best mineralised. The gangue consists of calcite, quartz, and, less commonly, dolomite, fluorspar and leverrierite (a hydrated aluminium silicate). The metalliferous minerals include arsenopyrite (auriferous), pyrite, stibnite (barren), realgar and orpiment (both auriferous). The best ore is a dark fine-grained quartz, which replaces limestone and coarse calcite. The minerals appear to have been deposited in the following order: (1) calcite, coarsely crystalline and barren; (2) fine-grained quartz, auriferous arsenopyrite and pyrite; (3) fluorspar and leverrierite; and (4) barren stibnite and auriferous realgar, together with later pyrite, quartz and calcite.

Chile.—An article on gold mining in Chile by L. Pitblado appears in the *Mining Mag.* (1921, **24**, 27). The Alhue Creek group of mines is characterised by E.-W. veins in diorite, which dip N. or S. The filling consists of hard bluish quartz mixed with rhodonite. The veins vary in thickness from 2 to 49 ft., the average being 6 ft. The average assay is 7 dwts. of gold per ton.

Reference to the occurrence of gold in the Black Sand Deposits of the Island of Chiloe, Chile, is made under "Platinum" (p. 105).

Iron

Rhodesia.—In *Bull.* No. 7, 1920, *Southern Rhodesia Geol. Survey* ("The Geology of the Enterprise Mineral Belt"), H. B. Maufe describes some important deposits of magnetite ore, which appear to be of unusual character and to be secondary deposits. The extent of these deposits has not been ascertained, but analyses show the ore to be practically free from phosphorus and to contain 64 per cent. of metallic iron. These deposits have been worked by natives in past years and two native furnaces have been found in their proximity.

Canada.—*Bull.* 104, 1920, *Canadian Inst. Min. and Met.* contains an article on the iron formation of the Michipicoten district of Ontario. This formation is composed essentially of banded silica, pyrite, siderite or sideritic limestone, and occasionally hæmatite in stratified layers, which have been extensively folded since their deposition. The iron deposits range in thickness from 2 to 500 ft., and in apparent length from a few yards to more than seven miles. They are associated exclusively

with volcanic formations. The pyritic ore of this formation varies in amount up to 90 per cent.

The twenty-ninth *Ann. Rept., Ontario Dept. Mines*, 1920, contains a report by J. G. Cross on the iron ore deposits in the Atibi Mattagami Area, Ontario. These deposits are at the Grand Rapids, on the Mattagami River, about seventy miles north of Mattagami station on the National Transcontinental Railway. The ore occurs in large irregular masses in limestone, and the deposits exist in two distinct zones, that at the foot and that at the head of the Grand Rapids; but the good ore appears to be restricted to a belt 600 ft. in width, forming the upper part of the latter. The ore consists chiefly of siderite, but limonite is found sparingly on exposed surfaces. The iron content of the better-grade ore is about 43 per cent. It is considered that the deposits may prove to be profitable on further investigation, but a large proportion is covered with glacial drift, and cannot therefore be examined, except by the diamond drill or by sinking through the drift.

China.—J. Coggin Brown (*Mem. Geol. Survey, India*, 1920, **47**, 82) states that iron ores have a wide distribution in Yunnan Province, but no extensive deposits are known. In one mine being worked the ore consists of brown hæmatite with some specular iron ore and magnetite. The ore is smelted with charcoal in a furnace from 7 to 8 ft. high, made of massive stone-work, the back and sides forming a rough semi-circle; this may be regarded as partly calciner and partly blast-furnace. In the manufacture of Chinese hemispherical cast-iron pans or bowls, which are found in all the bazaars of Upper Burma, the impure material from the furnace is always reduced with charcoal in a smaller and more powerful blast-furnace before metal pure enough for the purpose is obtained. One furnace produces from 130 to 260 lb. of iron in twenty-four hours. Other blast-furnaces are often from 20 to 25 ft. high, and from 6 to 7 ft. across at the widest portion, narrowing to 3 ft. at the hearth and at the mouth. The blast in all cases is produced by a cylindrical wooden blower, usually operated by a primitive turbine. The tuyère is generally cut from hard quartzite or sandstone. The industry is entirely local and there does not appear to be any scope for the treatment of iron ores in Yunnan by modern methods.

Peru.—According to J. J. Bravo (*Eng. and Min. Journ.*, Feb. 5, 1921, p. 263) important deposits of iron ore exist in Peru at Tambo Grande, Dept. of Piura; at Aija-

Callaycancha, Dept. of Ancachs; at Huacravilca, Prov. of Huancayo, and at Marcona in Ica. These deposits are stated to contain iron ore of good quality, and coal for smelting is obtainable within a reasonable distance. The Marcona deposit is said to contain at least 500,000,000 tons of high-grade hæmatite.

Lead

Union of South Africa.—An official report on the old Doornhoek Lead Mine, Marico District, Transvaal, has been published in the *South African Journ. Indust.* (1920, **3**, 1058), a summary of which is given later under the heading "Vanadium" (p. 108).

China.—According to J. Coggin Brown (*Mem. Geol. Survey, India*, 1920, **47**, 124) deposits of argentiferous galena occur in many parts of the province of Yunnan. In the Ming-kuan, about twenty-four miles east of the Burma frontier in the vicinity of Myitkyina, there is an ore-body of considerable width. The deposit consists of pyrite, with small amounts of pyrrhotite, and smaller quantities of chalcopyrite, galena and blende, in limestone. Blende is an almost invariable associate of galena in Yunnan. The mixed sulphite deposits of the Ming-kuan, and the reported occurrences in Keng-ma and Mĕng-hsa—where large quantities of slags are said to occur, samples of which in appearance are indistinguishable from those of Bawdwin, Upper Burma—are within comparatively short distance of the Burmese frontier. The exploitation on a large scale of the deposits of the far interior must depend largely on the future developments of communications in the province.

Limestone

Union of South Africa.—*Mem.* No. 11 (vol. ii), 1920, *Geol. Survey, Union of South Africa*, by W. Wybergh describes the limestone deposits of Natal, Cape Province and Orange Free State. Those of other parts of the Union were dealt with in vol. i of the same *Memoir* published in 1918. Natal is shown to be sparingly supplied with limestone, but, nevertheless, possesses sufficient for all industrial purposes if developed. In Cape Province, with the exception of the eastern districts, limestone is widely distributed, and the Orange Free State is also well supplied with limestone as well as with gypsum deposits. These limestones include several of economic value, but those suitable for making a natural cement are few in number. However, it is suggested by the author that the high price of Portland cement may lead to the development of a local cement-making industry.

Magnesite

Australia.—In this BULLETIN (1917, **15**, 291) a summary has been given of an official report by F. R. Feldtmann on the magnesite deposit at Bulong, in the north-east Coolgardie Gold-field, Western Australia. A. Gibb Maitland, in a recently published report on the "Magnesite Deposits of Western Australia" (*Min. Handbook Mem.* No. 1, *Western Australia, Geol. Survey*, chap. ii, *Econ. Geology*, 1919), gives some particulars with regard to the production and analyses of the Bulong mineral, and refers to similar occurrences in other parts of the state. A geological plan shows that the magnesite-bearing serpentines of Bulong stretch, in an irregular, somewhat narrow band, in a general N.S. direction for a length of about 1½ miles, on the western side of Lake Yindarlgooda. Farther west is a large parallel dyke of hornblende-quartz-porphyrite, whilst the areas between the serpentine and the lake and between the same rock and the dyke are occupied by "greenstones."

The following analyses of magnesite occurring in different parts of Western Australia were made in the Laboratory of the Geological Survey:

	Bulong.			Phillips River.		Waverley.	Comet Vale.	Coolgardie.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Magnesia, MgO	47·36	44·96	44·31	46·63	46·20	47·09	44·96	46·9[illegible]
Carbon dioxide, CO_2	51·69	49·33	47·76	51·13	51·58	51·62	48·10	51·2[illegible]
Combined water, H_2O	—	0·08	*nil*	—	*nil*	0·16	—	—
Moisture, H_2O	0·15	0·97	1·17	0·99	—	0·12	—	trace
Silica, SiO_2	0·12	1·12	4·99	0·28	0·29	0·16	—	0·6[illegible]
Alumina, Al_2O_3	—	—	—	0·19	0·32	0·61	—	1·0[illegible]
Ferric oxide, Fe_2O_3	0·16	0·56	0·42	—	0·24	0·20	1·38	
Ferrous oxide, FeO	—	—	—	0·10	—	—	—	—
Lime, CaO	*nil*	1·06	*nil*	1·34	1·43	trace	*nil*	*nil*
Sodium chloride, $NaCl$	0·53	1·76	1·39	—	—	—	—	—
Potassium chloride, KCl	0·01	0·09	0·08	—	—	—	—	—
Magnesium chloride, $MgCl_2$	0·08	*nil*	0·11	—	—	—	—	—
Sulphur trioxide, SO_3	trace	0·13	0·15	—	—	0·08	—	*nil*
Insoluble matter	—	—	—	—	—	—	5·76	—
	100·10	100·06	100·38	100·66	100·06	100·04	100·20	99·8[illegible]

The magnesite hitherto worked at Bulong has been obtained from quarries of various dimensions and of shallow depth. The deposit was first worked in 1915, and up to the end of 1917 an amount of 742 tons of magnesite had been quarried and exported. In 1918 the quantity exported was 62 tons, valued at £225.

The Phillips River magnesite (Analyses Nos. 4 and 5) occurs at several points to the north-east of the railway

between Kundip and Ravensthorpe, and has been used by the Phillips River Gold and Copper Co. for fluxing purposes and as a lining for the convertors. The magnesite is found on the surface as an alteration product of serpentinised rock. A considerable quantity of magnesite would appear to have been raised, but statistics are not available. Analysis No. 4 of a sample from Bandimup, Phillips River, shows that in composition this deposit is well above the standard (not less than 85 per cent. of $MgCO_3$) set for magnesite utilised for the production of oxychloride cement for tiles, flooring, etc. Analysis No. 5 is of a sample from Kundip, Phillips River. The Waverley deposit (Analysis No. 6) is in the Broad Arrow Gold-field, about twelve miles west-south-west from the Canegrass railway station. It is found in greenstones. Analysis No. 7 is of magnesite from Comet Vale, North Coolgardie Gold-field. This magnesite, in all probability, is in or is associated with serpentinised rock. Magnesite boulders are on the surface of the basic rocks in the Camel Farm Reserve, near Coolgardie (Analysis No. 8), and a little work has been done on a fair-sized vein of the mineral. Magnesite also occurs as a few small scattered veins in a belt of serpentine, or as fairly large nodules strewing the surface of the ground on the shores of Hannan's Lake, and many boulders of the same mineral are found scattered over the surface of the serpentinised rocks of Eulaminna, Mount Margaret Gold-field ; farther south, magnesite is also found in belts of serpentine between Yundamindera and Linden.

United States.—R. A. Bunkron, in *Eng. and Min. Journ.* (Jan. 8, 1921) describes the deposits and mining of magnesite in Stevens' Co., Washington, and also gives useful information regarding the magnesite industry generally. It is stated that magnesite is only found in important quantities in two places in the United States, one being in California, where the deposits yield the amorphous variety of the mineral, and the other in the State of Washington, where magnesite deposits are of the crystalline form. The crystalline type in the United States is used as a refractory, whilst the amorphous variety is suitable for miscellaneous uses.

Mercury

China.—A paper by Frank Trythall on " Quicksilver Mining in China," read at a meeting of the Cornish Institute of Engineers held on Feb. 19, 1921, is reported in the *Mining Mag.* (1921, **24**, 187). According to the author, mercury ores are found in the Toon-Yen prefecture, Kwei-chow

Province, South China, and have been mined for a very long period. The geological formation is mountain limestone stratified in horizontal beds several hundred feet in thickness, and the mineralised area is roughly three square miles. The ore deposits are, however, not continuous over this area, but occur irregularly in patches. The mercury mineral is cinnabar, the ore being found as impregnations in the limestone ; as filling joints, cracks, and planes of stratification ; as isolated bunches, nests or pockets ; and in cavities which contain crystalline aggregates of cinnabar associated with quartz and calcite. Irregular disseminations of cinnabar occur through a number of beds which have been subjected to local disturbance.

No systematic methods of mining are employed, the miners simply following rich veins or stringers of ore, with the result that a series of very intricate workings exist. The ore as mined is taken to the surface in baskets, strapped to the backs of coolies, and is there hand-picked.

Nickel

Union of South Africa.—Reference to deposits of nickel-copper ore in the Insizwa Range, Pondoland, is made under " Copper " (p. 91).

Canada.—A report by Cyril W. Knight on the " Nickel Areas of Windy Lake and other Districts of Ontario," appears in the 29th *Ann. Rept. Ontario Dept. Mines*, 1920.

Windy Lake is in the Sudbury district and the nickel deposit is similar in its character to that of Sudbury. Deposits also occur at Cedar and Net lakes, Munro, Lake Shebandowan, and in Fox Township in the Tumiskaming district. These deposits, however, while also closely resembling that of Sudbury in mineralisation, differ by being found in serpentine and at serpentine contacts, and in the case of the Fox Township deposits, as impregnations in gneiss in which no intrusions of basic rocks have so far been noted. It is not yet known if any of these are of commercial importance.

Petroleum

India.—In the first three numbers of the *Geol. Mag.* for 1921 there is an article by A. Preiswerk on the " Geological Features of the Oil Region in the Northern Punjab, India." The formation in which the oil springs occur is called the " Upper Nummulitic " by Wynne, and consists of variegated clays and marls with gypsum and layers of porous and compact limestones and beds full of

Nummulites and *Assilina* (Eocene). It lies on compact Nummulitic limestone, the top of which is often formed by cellular limestone (cargneule), and it is covered by immense sandstone beds. The predominant structure of the north-eastern border of the Western Salt Range is a typical example of folding.

Besides oil springs, salt springs occur, inflammable gases arise from the ground in one locality, and near Murat is a flat lenticular mass of tar below limestone boulders, capped by loess and lying on and impregnating vertical beds of sandstone and sandy clay. This occurrence is a further proof of the great extension of oil and bitumen in the Upper Nummulitic of the Punjab.

Canada.—At the March meeting of the Canadian Inst. Min. and Met., papers by J. Ness and E. M. Kindle were read on the "Mackenzie Oil Region," North-West Territories, Canada, and in April Dr. Bosworth read a paper on the same region before the Institution of Petroleum Technologists, London. Richly bituminous beds of Devonian age, one thousand feet or more in thickness, extend over many thousands of square miles, and are overlaid by 2,000 ft. of shales and sandstones from which seepages of oil arise, and this mass of petroliferous deposits is traversed by large anticlinal folds. On the flanks of the folds, on certain low parts of the crests, and on the minor structures, the petroliferous beds are more or less intact. The No. 1 test well, near Fort Norman, passed through the sandstones into the shales, and at 783 ft. a strong flow of oil was encountered, which spurted to a height of 70 ft. The initial output is thought to have been at least 500 barrels a day (*Abst. Oil News*, April 30, 1921, p. 446).

Dutch Borneo.—A paper by James Kewley on "The Crude Oils of Borneo" was read at a recent meeting of the Inst. Petr. Technol. (*Abst. Petr. World*, April 1921, p. 137). In the Koetei fields three distinct types of crude oil are found, viz. heavy asphalt oils in the upper strata, light asphalt oils at greater depths, and paraffin wax oils at still greater depths. A similar change in character with depth is found in the Alsace fields, but the Koetei crude oils possess an unusually large proportion of aromatic hydrocarbons, which, however, occur to a smaller extent in the wax oils than in the light asphalt oils. A possible source of the oil is to be found in the foraminifera limestone of the early Miocene, or, perhaps, in the marl formation of the underlying Eocene. It is possible that, as the oil migrated upwards, coming into contact with or

passing through the coal beds, some chemical interaction between the oil and the coal may have taken place; but there is need for further research.

Mexico.—Under the title "The Isthmian Oil Fields of Mexico" an article by Arthur H. Redfield appears in a recent number of the *Eng. and Min. Journ.* (March 19, 1921, p. 510). Redfield describes the zone of Minatitlan, which includes the Tehuantepec and the Tabasco-Chiapas fields. In the former field the oil occurs in a Cretaceous dolomitic limestone and is closely connected with salt domes, and in the latter the oil horizons are found in the loose sandstones and conglomerates of the Tertiary as well as in the coraliferous dolomite and dolomitic limestones of the Upper Cretaceous. Renewed attention has been drawn to these fields recently, although, up to the present, the output of oil therefrom has been insignificant, compared with that of the northern oil-fields.

Phosphates

Phosphate Rock in 1919.—Under this heading R. W. Stone, of the U.S. Geol. Survey, contributes a statistical article to the *Amer. Fertilizer* of March 12, 1921, regarding the United States phosphate industry, and also supplies useful descriptions of the phosphate deposits of Spain and other European countries, Algeria, Tunis, Morocco and Pacific Islands.

Platinum

Union of South Africa.—An article on the "Platinum Deposits of the Cape" appeared in the *South African Min. and Eng. Journ.* (Dec. 18, 1920, p. 384), giving extracts from two reports on the properties of the African Platinum Mines, Ltd., in the Transkei. It appears from these reports, and from information published since, that platinum occurs in the Transkei in alluvial or "semi-alluvial" (? detrital) deposits, and in altered dykes. Assays from the alluvial deposits proved to be very erratic as regards platinum-content. Assays from one of the dykes, which is said to be from 80 to 90 ft. in width, and to be traceable for miles, are stated to have yielded several pennyweights of platinum per ton. The average platinum-content of the whole width of the dyke in any one section is not stated.

A second dyke, discovered quite recently, is said to be 55 ft. in width. It is parallel to the first dyke and is also traceable for miles. Samples from this second dyke have yielded surprisingly rich results, but it should be noted that no real work had been done on it when these results

were published (*South African Min. and Eng. Journ.*, March 19, 1921, p. 840). Developments in this region will be watched with considerable interest.

Accessory amounts of platinum and gold have been found in the disseminated copper-nickel deposits of the Insizwa range, Pondoland, which lies north of the Transkei. These deposits are referred to under copper (p. 91).

Canada.—Reference to the occurrence of platinum in the Howry Creek area of Northern Ontario is made under "Arsenic" (p. 89).

Chile.—An article by Fritz Mella on the "Black Sand Deposits of the Island of Chiloe," Chile, appears in a recent number of the *Eng. and Min. Journ.* (March 19, 1921, p. 497). The highest gold contents were found in banded layers of heavy black and garnetiferous sands, varying from a thin knife-blade to 20 cm. in thickness. Platinum occurs in places with the black sand. The best platinum prospects occur at Lavaderos Beach; the seam, from 10 to 20 cm. in thickness, lies in a false bed-rock of clay, and appears to contain from 1½ to 2 grammes of platinum per cubic metre. It occurs in thin, flaky scales. An analysis yielded 10 per cent. of iridium. The platinum appears to be too erratic in deposition and too low in grade to be mined on a large scale.

Potash

United States.—The *Bull. Amer. Inst. Min. and Met. Eng.*, Jan. 1921, contains an abstract of a paper by Geo. R. Mansfield on "Potash in New Jersey Greensands." The potash occurs in sands in the form of glauconite to the extent of about 7 per cent. It is estimated that the New Jersey greensands contain 257,000,000 short tons of potash-bearing material that could be mined by open-pit methods.

Salt

China.—In his papers on the mineral resources of Yunnan Province, J. Coggin Brown gives an account of the salt industry of the district (*Mem. Geol. Survey, India*, 1920, **47**, 159; *Mining Mag.*, 1920, **23**, 340). In the Ting-Yuan Hsien district the salt is obtained as brine from wells sunk from the bottom of inclined shafts. The salt is found in the Red Bed Series (of J. Coggin Brown) of Permo-Triassic age, consisting of shales, sandstones and quartzites. At the surface the brine is conducted through open wooden launders into large wooden storage tanks sunk in the ground, and near the evaporating sheds. The

latter contain four furnaces, each fitted with from 20 to 30 hemispherical cast-iron pans from 2 to 4 ft. in diameter, supported on iron bars covered with brickwork. The entire top of the furnace is filled with clay and brickwork up to the level of the tops of the pans. The crude brine goes first into a large central pan, where it is heated and then filtered, whilst hot, through linen, into a second pan. As it becomes concentrated it is transferred again and again by means of a small wooden baler with a long bamboo handle until solid cakes of salt are obtained.

At Hou-ching (*ching* = well) there are three mines from which rock-salt is obtained. The salt occurs in patches and stringers in a hard red sandstone, of which a layer 20 ft. in thickness is being mined. The mine is worked by large galleries, pillars being left to keep up the arched roof of the working. The rock containing the salt is broken up, and then leached with water, the brine so produced being boiled down in the usual way. From Lau-ching, Hei-ching and Hou-ching the estimated output per annum is about 12,000 long tons.

Salt is a monopoly of, and is heavily taxed by, the Chinese Government. The introduction of European machinery at the salt wells and mines would no doubt result in an increased output at a considerably reduced cost.

Silver

Canada.—An article on the "Geology of the Portland Canal District," British Columbia, by V. H. Wilhelm, appeared in the *Min. and Sci. Press* (Jan. 15, 1921, p. 95). The ore-body of the Premier mine is a shear-zone in quartz-porphyry, striking N. 80° E. to S. 80° W., with secondary mineralisation along step-faults bearing N.E. to S.W. High-grade ore (mainly argentite) occurs along this secondary fissuring, and at the intersections of the shear-zone, especially along its hanging-wall side. A large body of low-grade complex sulphide milling ore is contained mainly between the step-faults. In the Missouri group of claims the formation consists of volcanic tuffs and scattered fragments of slate deposits, intruded by large masses of schistose quartz-porphyry. This primary sulphide ore-body is a residual surface sulphide zone. Assay of an average sample gave the following results: gold 0·03 oz., silver 2·3 oz. per ton; lead, 2·5 per cent.; zinc, 5·2; copper, 0·6; iron, 14, and insoluble matter, 59 per cent. These amounts of base metals indicate the presence of the following percentages of minerals: galena, 2·5; blende, 7·6; chalcopyrite, 1·55; and pyrite, 29·3. Over one million tons of ore of the above grade have

already been broken. The Spider Group is three miles north-east of the Missouri group. The ore-body is a shear-zone in which small high-grade veins intersect an older group of large low-grade quartz veins in an intrusive mass of augite-porphyrite. The ore gives the following percentages: zinc, 9·37; silica, 62·25; copper, 2·92; lead, 5·2; silver, 1·98; iron, 5·2; aluminium and sulphur, 13·68. In the Bear River Valley there are irregular complex sulphide ore-bodies in lenses or shear-zones in slate. Lenses of chalcopyrite containing gold and silver predominate.

United States.—An article on the Fairhaven Silver-head District, Alaska, appears in the *Min. and Sci. Press* (Feb. 2, 1921, p. 195). The ore-deposits consist of veins or contact shear-zones filled with fault material containing bodies of siderite replacing limestone to a variable extent. The ore consists of argentiferous galena, blende, and tetrahedrite with a small amount of pyrite. Galena and blende replace both limestone and siderite, and are therefore of later origin than the latter. The principal development shaft has a depth of 140 ft. One sample, taken at a depth of 18 ft., where the width was 5 ft., assayed 30·5 per cent. of lead, and 27·8 oz. of silver per ton. The level disclosed four separate faulted ore-bodies from 10 to 38 ft. wide and from 25 to 75 ft. long, yielding from 6 to 7 per cent. of lead and from 5 to 10 oz. of silver per ton. One ore-body gave 8 per cent. of zinc. On the 140-ft. level there was only one ore-body, averaging 5 ft. in width for a length of 35 ft., which assayed from 3 to 4 per cent. of lead and 2·5 oz. silver per ton. Clean galena replacing limestone, gave from 52 to 62 per cent. of lead and from 40 to 47 oz. of silver per ton, whilst the same mineral, replacing siderite, yielded 61 per cent. of lead and 54 oz. of silver per ton.

Sulphur

Union of South Africa.—The *South African Journ. Indust.*, Nov. 1920, contains a report by G. T. Trevor, Inspector of Mines, on sulphur production and consumption in the Union of South Africa. Deposits of sulphur and pyrites as a source of sulphur are discussed.

A little native sulphur is found in cavities in quartz in mines at Pilgrims Rest, and also in some other parts of the Union; but this material is of little importance commercially. Although it is suspected that many ferruginous outcrops of gossan form the capping to bodies of pyrite, so far only one occurrence of massive pyrite is known in the Union.

This deposit is at the Areachap Copper mine, situated about twenty-eight miles from Upington and ten miles from the railway. The gossan outcrop of this lode is 1,450 ft. in length and about 50 ft. wide. The gossan material includes small amounts of copper, and the original intention was to work the deposit as a copper mine. The sulphide zone is at a depth of 200 ft., and is said to maintain the surface width of the lode and to yield massive pyrites assaying 39 per cent. of sulphur.

During the war pyrite material concentrated from the tailings of certain gold mines in Natal was used for producing sulphur for sulphuric acid, and in 1919 these mines were still supplying 400 tons of pyrites per month. This by-product sulphur is said to be of considerable benefit, and may lead to the re-opening of several abandoned gold mines containing pyritic ore.

Canada.—In *Econ. Geol.* (1920, **15**, 574) Geo. Hanson describes several examples of Canadian pyrite deposits, and discusses the relationship of the form and structure of these deposits to the rocks which enclose them. It is concluded that the deposits have been formed through the agency of solutions from igneous sources, and reasons are given for disagreement with the theory that they have been deposited from meteoric waters.

Vanadium

Union of South Africa.—A joint report by Malcolm Fergusson, Inspector of Mines, and Percy A. Wagner, Government Geologist, on the old Doornhoek Lead mine, Marico District, Transvaal, appears in the *South African Journ. Indust.* (1920, **3**, 1058).

The deposit consists of soft, decomposed, bedded, manganese earth with thin layers of chert and large masses and boulders of dolomite, and occurs in the upper part of the dolomite formation. Galena in irregular nodules, from a fraction of an inch to over 2 ft. in diameter, is scattered through the manganese earth. Some of these nodules show traces of the original bedding of the dolomite, and are often covered with a thin film of brilliant red minium. In addition, cerussite, vanadinite (chloro-vanadate of lead) and pyromorphite are present in irregular layers, following the bedding of the manganese earth, as well as in pockets or encrusting vertical or steeply inclined joint planes. In the eastern part of the workings there is a big exposure of dolomite containing irregular masses and patches of galena, clearly developed by the replacement of the dolomite. The ore here is associated with fluorspar and talc.

With regard to the genesis of the deposit, the authors consider that the galena was introduced from a series of inclined fractures striking north-east by mineralising solutions that spread along the bedding planes of the dolomite. Later, the dolomite was altered to manganese earth through the agency of meteoric waters. The formation of the vanadinite appears to be connected with this later alteration.

The deposit is being worked partly by quarrying and partly by underground mining. Lead and vanadium ores occur in fairly consistent quantities throughout the deposit over a considerable area and thickness; but, at present, it is impossible to determine the extent of the deposits.

Seven samples gave from 8·15 to 15·5 per cent. of lead, and from an uncertain trace to 1·35 per cent. of vanadium pentoxide (V_2O_5). Of three other samples, one gave only traces of vanadium, one gave 0·15, and one 0·7 per cent. of vanadium pentoxide.

NOTICES OF RECENT LITERATURE

Products of the Empire. By J. Clinton Cunningham, B.A. Pp. 299, Crown 8vo. (Oxford: Clarendon Press, 1921.) Price 5*s*. 6*d*. net.

The conception of this little book is excellent. It is meant apparently as a school-book for commercial and geographical classes. The accounts of the most important products of the Empire, such as wheat, sugar, cotton, wool, jute, iron, tin, gold, coal, and petroleum are full, clear and accurate; and some minor products, such as quinine, indigo, aniline and incandescent mantles, are dealt with in an equally satisfactory manner. It is difficult to understand why rubber and timber are relegated to a position apart from other vegetable products after the "produce of mines"; and the detailed accounts of the gills of fish, the anatomy of the plaice, and, indeed, the whole chapter on food fishes, are perhaps rather out of proportion. The author exhibits throughout his work a tendency to take a somewhat too rose-coloured view of the prospects of British products, omitting, for example, any mention of the liability of Mauritius sugar-fields to hurricanes, of our coffee-plantations to the leaf-fungus from which Brazil is exempt, of the inferior quality of most Indian coal, or of the fact that Japan is now exporting refined and not crude camphor. Some statements are rather out of date, such as the forecast that Nigerian tin "will ultimately develop into one of the greatest sources of wealth of the Protectorate," whereas in 1918 it was

already second only to the oil-palm; and the absence of any reference to the use of nickel for coinage or of any menace to the West African monopoly of palm-oil. Slight, but, as we think, serious and remediable omissions are the description (p. 14) of starch as obtained from wheat, with no reference to it under rice, tapioca or arrowroot; the omission of any reference to the use of maize for distillation; of any discrimination between meal and flour; of any explanation of the way in which the ground-nut enriches the soil; and of any mention of African wild rubbers. Linseed oil is not described in the chapter dealing with oil-seeds, but appears as a secondary product of flax when fibres are dealt with; and in the same way paper-pulp is only incidentally referred to under timber. Ostrich-feathers and diamonds obtain the barest mention; wool is termed (p. 185) "the only product" of the Falkland Isles, the whale fishery being ignored; and Kirkcaldy alone, and not Staines, is given as the centre of linoleum manufacture. The suggestion (p. 229) that nuggets are rolled pebbles of gold rather than concreted dust is likely to mislead; and sleepers are by no means the chief purpose for which jarrah is imported from Australia (p. 278). The ecdysis or casting off of their "shell" by crustaceans (p. 53) is not precisely annual, and it should have been explained that the breeding of the oyster in estuaries, such as that of the Crouch in Essex, takes place in water which is not fresher, but more saline than that of the open sea. It is a mistake to speak of *Selaginella* to elementary students as a "moss" (p. 240); and we very much doubt if the name "woad" was ever accurately applied to *Reseda Luteola*; but the book unfortunately shows in this first issue that its author is unfamiliar with botanical terminology and nomenclature. The under-statement of the maximum height of maize as 18 instead of 30 ft. (p. 27) is a trivial matter, and Mr. Cunningham shares with most Englishmen the mistaken notion that the term "cob" applies to the whole ear instead of to its axis; winter and summer wheats are not varieties but races, each including numerous varieties; and there are undoubtedly several species of *Gossypium*, and not merely varieties. When the author (pp. 97 and 108) speaks of the leaves of coffee and cinnamon growing "on opposite sides of the stem" he apparently does not understand the technical meaning of opposite as applied to leaves. The awkward term "pinnate-shaped," employed on pp. 33 and 121, is not explained until p. 127; whilst "patinate-shaped" on p. 194 seems a mere blunder for "palmate," as, of course, are *Aurydalus* on p. 76 for

Amygdalus; Thea camellia (p. 91) for *Camellia Thea; Cacao Theobroma* (p. 101) for *Theobroma Cacao;* and *Rhamus infectorius* (p. 258) for *Rhamnus infectoria.* The statement on p. 61 that the banana belongs to the ginger family is hardly consistent with its reference just before to the *Musaceæ.* The only non-botanical blunder of this kind which we have noticed is the mention of "schulite" as an ore of tungsten on pp. 224, 225 and 226, and in the index, instead of "scheelite." Such things can be readily corrected in a new edition, and we hope the author may soon have the opportunity of thus rendering his book a trustworthy guide to the student of commerce.

THE TEXTILE MANUFACTURER YEAR BOOK, 1921. Pp. 344, 8vo. (Manchester and London: Emmott & Co., Ltd.) Price 3*s.* 6*d.* net.

This book has been compiled with the primary object of providing mill owners, managers, and others connected with the production and distribution of textiles with a handy collection of notes, rules, tables and data, many of which would not otherwise be readily accessible to them. Among the more important subjects dealt with are cotton buying and the cotton markets; the systems of numbering yarns, including the methods of arriving at the counts of yarns of the various textile fibres, and the diameters, weights, etc., of the different counts; cotton spinning data; cotton yarn costing; various weaving designs for cotton, woollen, worsted and union cloths; notes on cotton weaving and preparing machinery, humidification, dyeing, belting, rope and chain driving, electrical driving, and many other matters. Many useful tables are provided, and an account is given of the rules and regulations relating to the granting of patents.

The work is full of useful information, well and conveniently arranged, and will doubtless be of great value and utility to all engaged in the textile industries.

READING LIST ON PAPERMAKING MATERIALS. Compiled by Clarence Jay West. Pp. 170, Med. 8vo. (Cambridge, Mass.: Arthur D. Little, Inc., Chemists and Engineers, 1921.)

This work, which consists of a bibliography of papermaking materials, was originally published as Contribution No. 23 of the Committee on Bibliography, Technical Association of the Pulp and Paper Industry, United States, and has now been reprinted from the *Paper Trade Journal.*

In a few introductory pages the classification of papermaking materials and the methods of investigating them are briefly dealt with. In the bibliography, the various

materials are arranged alphabetically under both their common and botanical names, the references to the literature being given under the latter.

Unfortunately the book is marred by numerous errors and misprints. For example, we find on page 140 " Stinging nettle—See *Boehmeria* "; whilst on page 44 Boehmeria is correctly alluded to as the " stingless nettle." No reference to Urtica is made under the heading of " Stinging nettle," although on page 153 under Urtica, *U. dioica* is accurately described as the " common stinging nettle of Europe." Another striking instance of confusion occurs in the case of elephant grass. On page 65 we find " *Dennisetum purpureum*, Elephant grass " (obviously a misprint for Pennisetum), and a reference to literature is given which does not appear again under Pennisetum (on page 120), and so would be lost to the user of the bibliography. Under " Elephant grass " (on page 69) cross-references are made to *Dennisetum purpureum*, *Ochlandria travancorica*, and *Typha latifolia*, but *Pennisetum* is not mentioned.

Where numerous references to a book are made, the author's name only appears under the plant name, the intention being to give the full title of the book under the author's name in the alphabetical arrangement. Unfortunately several authors do not appear at all under the latter arrangement, the most striking omission being Liotard, so that although this name is seen on most pages of the bibliography the reader is at a loss to know the book it is intended to refer to. Presumably it is his *Memorandum on Materials in India Suitable for the Manufacture of Paper*, published in Calcutta, 1880.

Apart from these abundant mistakes, misprints, and omissions, the book is of great value, and supplies a long-felt want. It is hoped that in the preparation of a new edition care will be taken to ensure greater accuracy, and thus render the work even more serviceable to the student of paper-making materials.

Analysis of Paint Vehicles, Japans and Varnishes. By Clifford D. Holley, M.S., Ph.D. Pp. ix + 203, Demy 8vo. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1920.) Price 13*s.* 6*d.* net.

The author, who is Professor of Chemical Engineering in the University of Michigan, has described in concise language many of the more recent, and what he considers the most reliable, methods employed in the general analysis of paint and varnish products.

The first nine chapters deal with the examination of petroleum, turpentine, alcohol, naphthas, linseed and tung oils, and other paint vehicles; the methods of testing being very largely those adopted as standard methods by the American Society for Testing Materials. Chapters x to xvi discuss the analysis of liquid paints, one dealing especially with the effect of storage on their composition. In the remaining four chapters methods are given for the analysis of black baking japans, shellac, lacquers, and other varnish and enamel liquids. The volume contains a few illustrative diagrams, many useful tables, and a handy list of some of the more important literature bearing on the subject.

The book is essentially practical, and will undoubtedly prove useful to technical chemists, and more especially to those engaged in the analysis and manufacture of paint and varnish products.

Soil Alkali: Its Origin, Nature and Treatment. By F. S. Harris, Ph.D., Director and Agronomist, Utah Agricultural Experiment Station. Pp. xvi + 258, Demy 8vo. (New York: John Wiley & Sons; London: Chapman & Hall, Ltd., 1920.) Price 13s. 6*d.* net.

In spite of the large amount of research work which has been carried out on the nature and treatment of soils containing an excess of soluble salts, the present volume is the first to present a concise compilation of the results obtained. The term "soil alkali" is applied, not only to alkaline salts present in the soil, but also to any accumulation in the soil of soluble salts, such as the chlorides, sulphates, nitrates, and carbonates of sodium, potassium and magnesium, and the chloride and nitrate of calcium. Large tracts of alkali soils occur in India, Egypt, United States and Australia, and, after a brief description of these, the author discusses the origin of soil-alkali, its effect on plant growth, and the results of experiments designed to indicate the maximum quantities of the several salts which can be tolerated by various plants. The character of the native vegetation as an indication of the soil conditions is next considered, followed by a comprehensive account of the several field and laboratory methods which have been used for the accurate determination of the amount of soil alkali present. An account of the influence of soil alkali on the physical and biological character of the soil is given, together with methods of reclaiming affected land, whilst the crops suitable for such soils are also dealt with. The last two chapters discuss the effect of irrigation water containing soil-alkali and the methods by which the

probable value of alkali land for agricultural purposes may be judged.

The book has been carefully compiled from a wide range of material, and copious references to literature are given at the end of each chapter. It should be of service to all those who have to deal with the cultivation or reclamation of alkali soils, or with the irrigation of land in arid regions where such soils may occur.

MODERN MANUFACTURE OF CHEMICAL MANURES. Pp. 85, 8vo. (London : Sturtevant Engineering Co., 1920.)

This interesting little volume gives an account of the manufacture of chemical manures from the engineering standpoint, the plant described being almost entirely that made by the Sturtevant Engineering Co.

The machinery dealt with includes that used in crushing, screening and acid treatment of raw phosphates, together with that necessary for handling the raw material and finished products. Numerous labour-saving devices used during the course of the conveying, mixing and bagging of the products are described.

The somewhat brief descriptions of the plant are supplemented by numerous illustrations and diagrams.

AMMONIA AND THE NITRIDES. By E. B. Maxted, Ph.D., B.Sc. Pp. viii + 116, Crown 8vo. (London : J. and A. Churchill, Ltd., 1921.) Price 7*s*. 6*d*. net.

Considerable attention has been given during the past few years to the commercial synthesis of ammonia direct from its elements, and the first two chapters of this little volume discuss the theoretical principles and experimental work underlying the processes. Tables are given showing the efficiency of numerous catalytic substances, such as uranium carbide, osmium, cerium, manganese and tungsten. A good résumé of the work which has been carried out on the preparation and properties of nitrides is given in chapters iii to vi.

The concluding chapter deals with active nitrogen, and has been included because active nitrogen combines directly with many metals to give nitrides.

The value of the volume is enhanced by its numerous references to original communications.

THE GEOLOGY OF THE BRITISH EMPIRE. By F. R. C. Reed, M.A., Sc.D., F.G.S., F.R.G.S. Pp. viii + 480, Med. 8vo. (London : Edward Arnold, 1921.) Price 40*s*. net.

From the preface it appears that this work is based on notes of the author's lectures to Cambridge students. The geology of the British Isles has not been included, as

numerous excellent works on the subject are already available.

The work is well and concisely written, and is an excellent digest—admirably arranged—of all the important communications of recent date on the geology of our overseas possessions. The material is derived largely from memoirs, papers and articles scattered through numerous scientific and technical publications, and the book should therefore prove particularly useful to geologists and mining engineers living abroad in places unprovided with good scientific and technical libraries. Some of the smaller British possessions are dealt with briefly, on account of the scarcity of information, but countries which have been well studied and explored from a geological point of view are fully treated. The geology of India and Burma comprises 60 pages, with a bibliography of 156 references; that of the Union of South Africa has 41 pages, and a bibliography of 121 references; 61 pages are devoted to Canada and Newfoundland, and the bibliography includes 189 references; the geology of Australia is dealt with in 46 pages, and 20 pages are devoted to New Zealand. In the case of each country, provided the necessary material has been available, a summary is given of the general geological character, followed by details of the stratigraphy, and concluding with a brief summary of the economic geology. A number of geological sections and maps serve to illustrate the text; some of these are based on Geological Survey maps, and others are from private sources. Thus there is a geological sketch map of Burma by T. H. D. La Touche, maps of the North and South Islands of New Zealand by Park and Marshall, and a sketch-map of Australia, after David and others, whilst the geological map of New South Wales is based on maps by the Geological Survey and Süssmilch.

The work should prove useful, not only to geologists and mining engineers, but also to students of geology and mining.

Geology of the Non-metallic Deposits other than Silicates: Vol. I—Principles of Salt Deposition. By Amadeus W. Grabau. Pp. xvi + 435, 8vo. (New York and London: The McGraw-Hill Book Company, 1920.) Price 30s. net.

This volume is a handbook of salt geology, the term "salt" being employed to include nitrates, borates, phosphates and similar mineral deposits, and it sets forth the current interpretation of the conditions under which such deposits are formed.

The first chapter gives a concise and clear indication of what constitutes a salt in the chemical sense, and defines hydration and hydrates, water of crystallisation, solutions, and volume changes on solution. The chapter closes with a classification of the natural salts and salt-like substances. Chapter ii contains a valuable glossary of the principal properties, mode and places of occurrence of non-metallic salts (other than silicates), oxides, hydrocarbons and non-metallic elements, and this is followed by a chapter discussing the sea, lakes, etc., as sources of saline deposits, and the composition of sea and some other saline waters. The various kinds of deposits are next dealt with, such as marginal salt pans, marine salines and lagoonal deposits. Cyclic salts, which are defined as oceanic salts carried inland by the wind in the form of spray, are also referred to. Sambhar Lake, Rajputana, is considered to be an example of accumulated cyclic salts, and the accumulation is still proceeding. Salts of terrestrial, as distinct from marine origin, are stated to be more varied in kind and also more complex. Carbonates of lime and magnesia take the first place, and carbonate of soda is next in order. Under the term of "connate salts," a class of deposits in which the saline matter occupies the interstitial spaces in porous rocks is described. Deposits of supposed connate origin have several notable examples, amongst which are the Tarim or Lop Basin of Chinese Turkestan and the Great Salt Lake of Utah. In a chapter on salts leached from older rock salts, *i.e.* of secondary origin, the author instances the Dead Sea and various Russian and Hungarian lakes, while Lac Ritom in Switzerland is stated to be a strong solution of gypsum derived from neighbouring beds of that mineral. Reference is made to the solution and re-deposition of calcium and other carbonates from original deposits, and the conditions of such processes are defined. Salts formed as decomposition products of older rocks are considered; these are chiefly alkaline carbonates, the nitrates, alums, sulphates, and more rarely chlorides and borates. This source is shown to be an important one, accounting for many saline lakes in Canada, the United States and Siberia. A number of the principal deposits of this character are described; a notable omission is the Lake Magadi deposit in Kenya Colony, which is perhaps one of the most remarkable of the sodium carbonate deposits.

Concentration of salts by plant growth is shown to be of considerable magnitude, but it is somewhat surprising to find that the leaching of wood ashes, formed by the periodical firing of the vegetable growth of the Nebraska

plains, is considered to be the only source of the alkali salts in the lakes of that State. The playa or alkali flat deposits of complex salts are discussed. Examples of deposits of this class are found in Nevada and California. The occurrence and origin of nitrate deposits, and particularly those of Chile, are also referred to. A chapter on "Meta-Salts" deals with the alteration of limestone to gypsum; the hydration of anhydrite to form gypsum, and the converse; the dolomitisation of limestone; kaolinisation; the formation of alunite, and of both amorphous and crystalline magnesite. An account of the changes in structure and occurrence imposed on salt bodies by earth pressure includes a discussion of the famous "salt domes," such as those of Texas and Louisiana. The final chapter deals with the conditions of salt deposition in some of the older geological periods.

This volume is a valuable addition to the literature of the subject of which it treats, and should find a place in every geological library. It bears evidence of careful research, and will be a great aid to the comprehension of the origin of the various salt deposits of the world.

Economic Mineralogy. By T. Crook, A.R.C.Sc., F.G.S. Pp. xi + 492, 8vo. (London: Longmans, Green & Co.) Price 25*s*. net.

The aims of this volume are purely utilitarian, and it should make a strong appeal to all students of mineralogy and to engineers, particularly as this aspect of the science has not received due consideration from British authors in the past. The introductory chapters are brief, the sections on such branches of the subject as crystallography, crystal optics, etc., consisting of terse definitions and short, clear explanations of salient features. There is a useful chapter on the physical analysis of fragmentary rock-samples, and the introductory matter concludes with an account of the origin of rocks and minerals and their modes of occurrence, which involves reference to the principles of dynamic geology and the elements of stratigraphy. Before commencing the detailed descriptions of minerals the author apologises for the "comparative crudity" of the method of classification employed, viz. according to their uses; but having regard to the main objects of the book, the apology seems unnecessary.

The minerals dealt with are grouped under three headings: (*a*) Ore minerals (under their respective metals which are arranged alphabetically); (*b*) Gem minerals (alphabetically); (*c*) Miscellaneous economic minerals (*i.e.* the "non-metallic minerals"). Admirable judgment has

been shown in the selection of the various characteristics listed. In cases where minerals might be included under any or all of the above headings, redundancy has been avoided by cross-references. The information in these chapters has been carefully and accurately compiled, and is remarkably complete and up-to-date, particularly in respect of the localities cited. The illustrations include diagrams and a number of photographic reproductions of specimens in the British Museum, the latter being uniformly clear. The volume concludes with determinative tables of minerals and a good index.

Throughout the book there are no references to the sources from which the information was obtained, and this omission detracts from its value. In future editions, methods for the detection and estimation of radium might with advantage be included to complete the usefulness of this well-written and serviceable work.

TECHNICAL METHODS OF ORE ANALYSIS. By Albert H. Low, B.S. Eighth Edition. Pp. xvi + 388, 8vo. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1919.) Price 19*s*. net.

The fact that this well-known textbook of ore analysis has now reached its eighth edition is good evidence of its utility. Briefly it may be said to differ from the preceding edition in the fact that further methods are added for the determination of molybdenum, uranium, tungsten and potassium. The methods described include those for the estimation of all the common metallic and non-metallic elements, and for the analysis of boiler water, coal and coke, and crude petroleum. In all cases details are given to ensure the accurate carrying out of the methods described, and many of the directions embody the results of the author's personal experience. Frequently reference is made to the original communications in which the method was described. It is to be regretted that the author has not included certain of the "rapid" methods in vogue in some works' laboratories, such as that for the estimation of arsenic by distillation. The book is intended for both technical chemists and students, and will undoubtedly continue to prove useful to both.

THE CHEMICAL ANALYSIS OF STEEL-WORKS' MATERIALS. By Fred Ibbotson, B.Sc., F.R.C.Sc.I., F.I.C. Pp. viii + 296, 8vo. (London: Longmans, Green & Co., 1920.) Price 21*s*. net.

This volume is a new and revised edition of the chemical section of Brearley and Ibbotson's *Analysis of Steel Works' Materials*, published in 1902.

The introductory chapter, which deals with "General Processes," discusses methods for separating iron from other metals, the use of nascent hydrogen in inorganic analysis and of mercurous nitrate as a precipitant for tungsten, chromium, molybdenum and vanadium. The analysis of steel and pig-iron is dealt with in a comprehensive manner in Part II, and methods are given for the estimation of practically every element which may be found in these metals. The analysis of steel-making alloys is the subject of Part III, whilst Part IV describes the complete analysis of the ores of iron, manganese, tungsten and chromium. The remainder of the book deals with the chemical examination of refractory materials, slags, fuel and boiler water.

Many useful references to original publications are given, and the book contains numerous practical hints of a time- and labour-saving character, which should prove of service even to those chemists whose inorganic analytical work is not confined to the examination of steel-works' materials.

RECOVERING PRECIOUS METALS FROM WASTE LIQUID RESIDUES. By George E. Gee. Pp. viii + 380, 8vo. (London: E. and F. N. Spon, Ltd.; New York: Spon & Chamberlain, 1920.) Price 16*s*. net.

The present high prices of platinum, gold and silver render the recovery of these metals from waste products of considerable importance to many trades. The publication of the present volume, which appears to be the first issued in English on the subject, is therefore opportune. Precious metal waste is produced chiefly in the jewellery, photographic, process working and electroplating trades, and the book has been written largely for the use of those engaged in these occupations.

The volume is essentially of a practical character, and is written in such a manner as to be intelligible to the non-scientific reader. Thus, when it is necessary to employ a chemical substance, its composition and properties, and the precautions to be observed in its use, are described in simple language.

The book should prove of service to all who have to handle waste products containing the precious metals in recoverable quantity.

THE USE OF LOW-GRADE AND WASTE FUELS FOR POWER GENERATION. By John B. C. Kershaw, F.I.C. Pp. x + 202, 8vo. (London: Constable & Co., 1920.) Price 17*s*. net.

The increasing cost of all forms of fuel has led to considerable attention being devoted to the possibility of

utilising certain low-grade materials, previously neglected, and to the better employment of certain other fuels. The importance of the utilisation of low-grade fuels in the United Kingdom is well illustrated by the fact that from 15 to 30 per cent. of the coal now being worked in our mines is purposely left underground because there is no profitable sale for it at the pit head. Moreover, of the material brought to the surface a large proportion is not utilised, as is evidenced by the heaps of shale, culm and washery waste at the pit's mouth.

The present work, which is based on articles published in the Press during the war, deals with the possible utilisation of peat, lignite, bagasse, wood waste, coal and coke, breeze, culm and washery waste, town garbage, pitch and waste gases. The materials are considered from the practical standpoint, and numerous figures are given relating to the efficiency, etc., of plants in operation, together with plans showing the design and lay-out of the works. The second part of the book, entitled "Scientific Control," deals with the sampling and testing of the fuels and waste gases, together with a chapter on the design and management of furnaces and boilers for high efficiencies.

The book gives a useful summary of the present position of the utilisation of low-grade and waste fuels.

Liquid Fuels for Internal Combustion Engines: A Practical Treatise for Engineers and Chemists. By Harold Moore, M.Sc.Tech., A.I.C., F.C.S., A.M.I.Pet.Tech. Second Edition. Pp. xv + 206, 8vo. (London: Crosby Lockwood & Son, 1920.) Price 15*s*. net.

Economies necessitated by the high price of liquid fuels during the war led to the more efficient utilisation of certain of them which had not been previously regarded with favour by users of internal combustion engines. An up-to-date work on the subject of liquid fuels is therefore of considerable interest and utility.

The first part of the present volume deals with the sources and properties of a number of substances used as liquid fuel, such as petroleum and shale oil; lignite, coal and blast furnace tars; the products of wood and peat carbonisation; animal and vegetable oils; and the alcohols. The suitability of these fuels for use in internal combustion engines is considered in Part II; the several types of engines being grouped under (1) engines fitted with carburetters (generally known as petrol motors); (2) engines fitted with simple vaporisers (generally known as paraffin motors); and (3) engines fitted with fuel pumps and atomising devices, such as the Diesel and semi-Diesel

types. This section is particularly useful, as it deals with the numerous fuels from an essentially practical standpoint. Typical analyses are given, and in many cases the performance of the fuel in the engine is illustrated by means of an indicator diagram.

The chemical and physical testing of liquid fuels is discussed fully in the third part of the book, where the author describes not only the methods of carrying out the tests, but also their bearing on the use of the fuel in internal combustion engines. As would be expected from a knowledge of the author's own research work, considerable attention is devoted to methods for the determination of the temperature of spontaneous ignition, which it may be remarked has but little connection with either the flash point or burning point.

An appendix contains tables of calorific values and of the quantities of air required for the combustion of liquid fuels, typical analyses of several fuels, and the temperatures of spontaneous ignition of a large number of substances. Specifications for several of the more important fuels are also given.

The book should be of value to all interested in the subject, whether from the chemical or engineering standpoint.

BENZOL: ITS RECOVERY, RECTIFICATION AND USES. By S. E. Whitehead, B.Sc. Eng. Pp. xiv + 207, Med. 8vo. (London: Benn Bros., Ltd., 1920.) Price 12*s.* 6*d.* net.

Although methods for the extraction of benzene and its homologues from coal gas had been in use to some extent prior to 1914, it was the great demand for these substances occasioned by the war that led to such processes being generally adopted in this and other countries. Benzol is obtainable from two products resulting from the carbonisation of coal, viz. tar and gas, and it is chiefly with the latter source that the present volume is concerned. The quantity of benzol recoverable from coal gas varies with the coal used and ranges from 1½ to 3½ gallons per ton of coal. Owing to the small yield, considerable attention has to be given to the efficiency of the methods used. The author considers that the removal of benzol from coal gas ("stripping") is economically sound, because one gallon of benzol sold in coal gas only realises about 2*d.*, whereas if separated and sold as motor fuel it is worth 3*s.* 3*d.*

The book deals with the recovery of benzol from coal gas, its rectification and its uses. The value of benzol

as a motor fuel is discussed, and this will be of interest to many not directly concerned with its production. An important feature of the volume is the practical information given with regard to the precautions necessary, and the difficulties which may occur, during the operations described. The descriptions of plant are augmented by a large number of diagrams, and the book should be of service to all who have to deal with the recovery of benzol, its rectification or its use.

THE CERAMIC INDUSTRIES POCKET BOOK. By A. B. Searle. Pp. vii + 267, Pott 8vo. (London: Sir Isaac Pitman & Sons, Ltd., 1920.) Price 8s. 6d. net.

This volume is a compilation of data likely to be of service to those interested in the ceramic industries, whether from the scientific or technical standpoint. As might be expected, it contains a certain amount of matter which is common to most works of this character, and acknowledgment is made for about 28 pages taken from the *Mechanics' Pocket Book.* In the section devoted to "the materials used in manufacture" the author gives a number of tables showing the physical properties of ceramic materials, including the refractoriness of mixtures of clay, quartz, felspar, etc., which will be useful to those carrying out investigations on such materials. Succeeding sections deal respectively with water and steam; materials used for the manufacture of plant and machinery; mechanics and dynamics; and machinery. The last three sections of the book should prove of value to the practical worker, as they deal with the drying of clay-ware, burning and kilns, and ceramic calculations.

BOOKS RECEIVED

ANGLO-SOUTH AMERICAN HANDBOOK FOR 1921. Edited by W. H. Koebel. Pp. cxiv + 929, Crown 8vo. (London Federation of British Industries, 1921.) Price 25s. net.

THE BASES OF AGRICULTURAL PRACTICE AND ECONOMICS IN THE UNITED PROVINCES, INDIA. By H. Martin Leake, M.A., Sc.D., F.L.S. Pp. viii + 278, Demy 8vo. (Cambridge: W. Heffer & Sons, 1921.) Price 15s. net.

COMMERCIAL COMMODITIES. By Frank Matthews, B.Sc., A.I.C., F.C.S. Pp. vi + 319, Demy 8vo. (London: Sir Isaac Pitman & Sons, Ltd., 1921.) Price 12s, 6d. net.

THE BANANA: ITS CULTIVATION, DISTRIBUTION AND COMMERCIAL USES. By William Fawcett, B.Sc. (Lond.). With an Introduction by Sir Daniel Morris, K.C.M.G., D.Sc., D.C.L., F.L.S. 2nd edition. Pp. xi + 299, Med. 8vo. (London: Duckworth & Co., 1921.) Price 15*s*. net.

COCOA AND CHOCOLATE: THEIR CHEMISTRY AND MANUFACTURE. By R. Whymper. 2nd edition. Pp. xxi + 568, Crown 8vo. (London: J. & A. Churchill, 1921.) Price 42*s*. net.

THE SWEET POTATO: A Handbook for the Practical Grower. By T. E. Hand and K. L. Cockerham. Pp. xi + 261, Crown 8vo. (New York: The Macmillan Co., 1921.) Price 16*s*. net.

CONDENSED DESCRIPTION OF THE MANUFACTURE OF BEET SUGAR. By Franz Murke, Ph.D., A.M. Pp. 175, Demy 8vo. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1921.) Price 15*s*. net.

THE DISEASES AND PESTS OF THE RUBBER TREE. By T. Petch, B.A., B.Sc. Pp. x + 278, Med. 8vo. (London: Macmillan & Co., Ltd., 1921.) Price 20*s*. net.

RUBBER PLANTING: A Book for the Prospective Estate Assistant in British Malaya. By C. Warde Jackson. With a foreword by A. B. Milne, and a new map of British Malaya. Pp. iv + 63, Demy 8vo. (Kuala Lumpur: The Incorporated Society of Planters, 1920.) Price 3*s*. 6*d*. post free.

CHEMISTRY OF PULP AND PAPER MAKING. By Edwin Sutermeister, S.B. Pp. vii + 479, Demy 8vo. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1920.) Price 36*s*. net.

MODERN PULP AND PAPER MAKING: A PRACTICAL TREATISE. By G. S. Witham, S.R. Pp. 599, Med. 8vo. (New York: The Chemical Catalog Company, Inc., 1920.) Price $6.50 post free.

DIRECTORY OF PAPER MAKERS OF THE UNITED KINGDOM FOR 1921. (London: Marchant Singer & Co., 1921.) Price 2*s*. net.

APPLICATION OF DYESTUFFS TO TEXTILES, PAPER, LEATHER AND OTHER MATERIALS. By J. Merritt Matthews, Ph.D. Pp. xvi + 768, Demy 8vo. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Limited, 1920.) Price 57*s*. 6*d*. net.

THE PRACTICE OF SYLVICULTURE, WITH PARTICULAR REFERENCE TO ITS APPLICATION IN THE UNITED STATES. By Ralph C. Hawley. Pp. xi + 352, Demy 8vo. (New York; John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1921.) Price 22*s*. net.

APPLIED COLLOID CHEMISTRY: GENERAL THEORY. By Wilder D. Bancroft. Pp. viii + 345, Demy 8vo. (New York and London: McGraw-Hill Book Company, Inc., 1921.) Price 18*s*. net.

MINERALOGY: AN INTRODUCTION TO THE STUDY OF MINERALS AND CRYSTALS. By E. H. Kraus and W. F. Hunt. Pp. xiv + 561, Med. 8vo. (New York and London: McGraw-Hill Book Co., Inc., 1920.) Price 27*s*. net.

POWDERED COAL AS A FUEL. By C. F. Herington. 2nd Edition. Pp. xii + 338, Med. 8vo. (London: Constable & Co., Ltd., 1920.) Price 30*s*. net.

FIELD METHODS IN PETROLEUM GEOLOGY. By G. H. Cox, Ph.D., E.M., C. L. Dake, M.A., and G. A. Muilenburg, M.A. Pp. xiv + 305, Crown 8vo. (New York and London: The McGraw-Hill Book Company, Inc., 1921.) Price 24*s*. net.

OIL SHALE INDUSTRY. By V. C. Alderson, Sc.D. Pp. ix + 175, Demy 8vo. (New York: Frederick A. Stokes Company, 1920.) Price 26*s*. net.

LUBRICATING AND ALLIED OILS. A Handbook for Chemists, Engineers and Students. By Elliott A. Evans, F.C.S., A.M.I.P.T., with foreword by Sir Charles Cheers Wakefield, Bart., C.B.E., D.L., J.P., etc. Pp. xiv + 128, Med. 8vo. (London: Chapman & Hall, Ltd., 1921.) Price 9*s*. 6*d*. net.

THE TECHNICAL EXAMINATION OF CRUDE PETROLEUM, PETROLEUM PRODUCTS AND NATURAL GAS. By William Allen Hamor, M.A., and Fred Warde Padgett, M.S. Pp. viii + 591, Med. 8vo. (New York and London: McGraw-Hill Book Company, Inc., 1920.) Price 36*s*. net.

THE TIN RESOURCES OF THE BRITISH EMPIRE. By N. M. Penzer, M.A., F.R.G.S., F.R.A.S., F.G.S. Pp. x + 358, Demy 8vo. (London: William Rider & Son, Ltd., 1921.) Price 15*s*. net.

HANDBOOK OF METALLURGY. By Dr. Carl Schnabel, translated by Henry Louis, M.A., D.Sc. 3rd Edition. Vol. 1. Copper, Lead, Silver, Gold. Pp. xxi + 1171, Med. 8vo. (London: Macmillan & Co., Ltd., 1921.) Price 40*s*. net.

AN OUTLINE OF THE METALLURGY OF IRON AND STEEL. 3rd Edition. By A. Humboldt Sexton, F.I.C., F.C.S., and J. S. G. Primrose, A.G.T.C., A.I.M.M. Pp. xv + 572, Med. 8vo. (Manchester: The Scientific Publishing Company.) Price 15s. net.

ELECTROLYTIC DEPOSITION AND HYDROMETALLURGY OF ZINC. By Oliver C. Ralston. Pp. 201, Med. 8vo. (New York and London: McGraw-Hill Book Company, Inc., 1921.) Price 18s. net.

METALLIC ALLOYS: THEIR STRUCTURE AND CONSTITUTION. By G. H. Gulliver, D.Sc., F.R.S.E., A.M.I.Mech.E., M.Inst.M. 4th Edition. Pp. xxviii + 439, Post 8vo. (London: Charles Griffin & Company, Ltd., 1921.) Price 15s. net.

COKE-OVEN AND BY-PRODUCT WORKS CHEMISTRY. By Thos. Biddulph-Smith, F.C.S. Pp. x + 196, Med. 8vo. (London: Charles Griffin & Company, Ltd. 1921.) Price 21s.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Dominion, Colonial and Indian Governments.

MANILA HEMP: CAUSE OF DAMAGE IN RECENT CONSIGNMENTS

THE attention of the Imperial Institute was drawn recently by a firm of fibre merchants to the fact that certain consignments of Manila hemp received in the United Kingdom had been found very deficient in strength. Samples of the defective fibre were forwarded to the Imperial Institute for examination with a view to ascertaining the cause of the inferiority, and the results of the investigation are given in the following pages.

The samples received were as follows:

No. 1. *Badly Damaged.*—This fibre was mostly coarse and harsh, not very lustrous, and of pale brown colour, with portions of a darker tint and some greyish-buff fibre. The material on the whole was well cleaned, but a small quantity of powdery matter was present, apparently produced from the disintegration of some of the fibre. The strength of the fibre was variable, and, on the whole, poor.

No. 2. *Partly Damaged.*—This fibre was on the whole very similar to No. 1, but stronger and fairly free from powdery matter.

No. 3. *Slightly Damaged.*—This fibre resembled samples Nos. 1 and 2 in general appearance, but the strength was better, and, although somewhat variable, was on the whole fairly good. It was fairly free from powdery matter.

Sample J.—This material, stated to be the worst sample so far met with, was somewhat darker in colour than

Nos. 1, 2 and 3, but otherwise resembled these in appearance. It was very weak, and could be readily disintegrated into powder.

The fibres were chemically examined at the Imperial Institute with the following results, which are shown in comparison with the corresponding figures for two samples of commercial Manila hemp of good quality. The figures are expressed on the moisture-free fibre.

	No. 1 (Badly damaged).	No. 2 (Partly damaged).	No. 3 (Slightly damaged).	Sample J (Worst sample).	Commercial samples of good quality.	
					A.	B.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Ash	4·7	5·1	5·0	3·7	1·1	2·4
α-Hydrolysis, *loss* . .	23·6	21·4	13·6	20·0	11·2	12·0
β-Hydrolysis, *loss* . .	32·0	29·2	20·4	28·8	17·8	18·5
Acid purification, *loss* .	12·2	9·2	6·4	—	1·6	1·8
Loss on washing in water	8·1	6·0	6·3	9·2	—	1·3
Cellulose	63·5	64·6	67·5	61·2	78·6	76·8
Acidity expressed as milligrams of potash (KOH) per gram of fibre as received:						
(1) Total . . .	3·9	—	2·03	3·4	—	1·1
(2) Volatile . .	0·23	—	0·21	0·21	—	0·19

The ash of sample No. 2 was analysed and the results are summarised below, in comparison with those obtained for the ash of the commercial sample B. The figures are in each case expressed on the entire ash.

		Sample No. 2.	Commercial sample B.
Portion soluble in water:		*Per cent.*	*Per cent.*
Chlorine	Cl . . .	7·74	5·48
Sulphuric anhydride	SO_3 . .	1·33	4·31
Carbon dioxide	CO_2 . .	17·60	14·17
Phosphoric anhydride	P_2O_5 . .	trace	trace
Silica	SiO_2 . .	2·93	1·63
Alumina and ferric oxide	Al_2O_3 and Fe_2O_3	0·40	0·20
Lime	CaO . .	nil	1·83
Magnesia	MgO . .	0·40	0·08
Soda	Na_2O . .	22·70	2·91
Potash	K_2O . .	18·91	44·85
Portion insoluble in water:			
Silica	SiO_2 . .	8·91	4·12
Alumina	Al_2O_3 . .	5·49	2·42
Ferric oxide	Fe_2O_3 . .	1·14	0·93
Manganous oxide	MnO . .	trace	0·06
Lime	CaO . .	7·19	9·81
Magnesia	MgO . .	3·15	4·47

It will be seen from the results given in the foregoing tables that the percentages of ash in the samples of defective fibre are rather high as compared with the amounts usually yielded by commercial Manila hemp of good quality, which vary from 1 to 2·5. Quantities up to 5 per cent. are, however, occasionally met with in fibres of normal quality, whilst the results of the analysis of the ash of sample No. 2 given above show that the ash was of generally similar character to that of the commercial sample B, and did not show any abnormality in composition; the variations in the two analyses are probably mainly due to differences in the composition of the soils on which the two fibres were grown. In this connection it may be mentioned that according to a statement in the *Philippine Agricultural Review* (1908, **1**, 314), the ash of commercial Manila hemp amounts to about 4 per cent. of its dry weight.

The loss on boiling the fibre with dilute caustic alkali for five minutes and one hour respectively (α- and β-hydrolysis) is abnormally high in the defective samples 1, 2 and J, whereas in the case of No. 3, described as only "slightly damaged," the loss is not much higher than in the case of normal commercial samples. The loss increases generally with the weakness of the fibre.

The losses on washing with water and on acid purification (treatment with hot 20 per cent. acetic acid) are much higher than those given by normal Manila hemp, and increase with the weakness of the fibre.

It will be seen that the percentages of cellulose in the defective fibres are abnormally low, even in the case of No. 3, and that the figures decrease with decrease in strength of the fibre. Sample J contains only 61·2 per cent. of cellulose, whereas an average Manila hemp seldom contains less than 75 per cent. of this constituent.

The total acidity is higher in the damaged samples than in normal Manila fibre, but the amount is very small, and the proportion of volatile acids is negligible and not materially different from that contained in the normal samples.

The results of the examination of these samples of

fibre indicate that the damaged hemp has been affected by some fermentative process, leading to the degradation of part of the cellulose, with formation of decomposition products soluble in water, and an increase in the amount of matter soluble in hot dilute alkali and in acetic acid. This is supported by the fact that the weaker and more damaged the fibre the lower is the percentage of cellulose which it contains and the greater the loss of weight on treatment with hot water, dilute alkali or acetic acid.

The following experiments were carried out with the object of testing the validity of this conclusion.

Effect of maintaining the Moist Fibre at a Temperature of about 90° *F.*—In order to study the changes which take place in the chemical composition of Manila hemp when exposed to excessive moisture at a tropical temperature, a portion of the " slightly damaged " sample No. 3 was maintained at a temperature of 86°–95° F. for a period of twenty-five days, the fibre being previously moistened with water and tightly packed into a small bundle covered with calico. The sample B (of good quality) was treated similarly. The bundles were re-moistened from time to time, and at the end of the period were opened and dried in the air. After this treatment sample No. 3 was found to be noticeably weaker and of a duller colour, especially at the centre of the bundle, the outside not having been so much affected, probably because it was not kept so moist as the interior and was more exposed to the air. A very slight amount of black mould was found in the fibre, and the bundle had a slightly musty odour. The inner portion, amounting to about half the bundle, was submitted to chemical examination (see below), as representing the fibre which had undergone the most pronounced change owing to the treatment.

The " good " sample B, after treatment, was found to be unchanged in appearance and not appreciably weaker than before the treatment. It showed no black mould. It was submitted to examination as before.

The following table gives the results (expressed on moisture-free material) yielded by the fibres both before and after treatment.

	Sample No. 3.		Sample B.	
	Before treatment.	After treatment.	Before treatment.	After treatment.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Ash	5·0	5·1	2·4	2·6
α-Hydrolysis, *loss* . .	13·6	16·9	12·0	13·5
β-Hydrolysis, *loss* . .	20·4	29·7	18·5	20·9
Acid purification, *loss* . .	6·4	7·8	1·8	3·0
Loss on washing in water .	6·3	7·1	1·3	2·5
Cellulose	67·5	62·2	76·8	73·4

The treatment did not produce any marked effect on the acidity of the fibre in either case.

It will be seen, from these figures, that in each case the effect of maintaining the moist fibre at a temperature of approximately 90° F. was to reduce the percentage of cellulose in the fibre and to increase the losses on hydrolysis, acid purification and washing in water. Sample No. 3 was noticeably weaker after the treatment, but in the case of Sample B the fibre still retained good strength although the percentage of cellulose had fallen by 3·4 per cent. This is accounted for by the fact that the fermentation had not proceeded very far, the cellulose percentage being still as high as 73·4.

The effect of heat and moisture is thus to produce changes in the composition of the fibre similar to those which had occurred in the damaged samples, the action in the case of sample No. 3 being merely a continuation of that which had already taken place in the material.

Conclusions and Remarks

These investigations show that the damage which had taken place in the consignments of Manila hemp under consideration was due to a degradation of the cellulose, doubtless of bacterial origin, promoted by prolonged storage in a moist condition at a tropical temperature. This is confirmed by the fact that, on placing the fibre under similar conditions in the laboratory, the cellulose undergoes further degradation and the fibre simultaneously increases in weakness.

It may be pointed out that the fact that the storage of Manila hemp in a moist condition causes serious injury

to the fibre is well known in the Philippines, as is evident from the following statement which occurs in *Farmer's Bulletin* No. 12, *Bureau of Agriculture, Manila*, p. 32: "In all districts where abaca [Manila hemp] is most successfully cultivated the rainfall is abundant and the distribution fairly even throughout the year. This fact, while favourable for the growth of abaca, is also in part responsible for the immense quantities of inferior fibre that flood the market, as during the rainy weather bundles of wet fibre are packed indoors. To keep the fibre spread out on bamboo poles out of doors is better than keeping it inside, but the successive changes of sun and rain prevent its drying with the required colour and lustre."

It is evident, therefore, that in order to avoid deterioration of Manila hemp the utmost care should be exercised in the Philippines in drying the fibre and in ensuring that it is not stored or baled in a moist state.

The lower grades of Manila hemp, such as those which form the bulk of the material imported into this country, are those most likely to be affected by damp. Fermentation is liable to be more pronounced in such grades, as they are not so well cleaned as fibre of the better classes and contain more easily fermentable material in the form of parenchymatous tissue.

IMPROVEMENT OF NIGERIAN GROUND NUTS

LARGE quantities of ground nuts are grown for export in Nigeria, the average annual shipments during the four 5-year periods ending 1905, 1910, 1915 and 1920 being as follows: 513 tons, 1,572 tons, 9,778 tons, 48,500 tons. The greatest quantity shipped in any one year was 57,554 tons in 1918.

Most of the ground nuts are produced in the Northern Provinces, particularly in the Kano and Zaria regions, but attempts are being made to extend the cultivation in the Southern Provinces. With this end in view, different varieties are being grown experimentally on the Moor Plantation at the Government Station at Ibadan, and three series of samples of the nuts produced have been examined during recent years.

Series I

In this series, which was forwarded in March 1918, three varieties were represented, viz. Chinese, Gambia, and Zaria. In each case undecorticated nuts, selected kernels and unselected kernels were sent. The characters of the nuts and kernels were as follows:

	Chinese variety.	Gambia variety.	Zaria variety.
Undecorticated nuts	Clean and unbroken	Clean and unbroken	Clean and unbroken
Selected kernels	Large, plump, rather dark coloured and dirty	Small, plump, rather dark coloured and dirty	Large, plump, rather dirty
Unselected kernels	Large, rather shrivelled, somewhat dark coloured and dirty	Small, plump, mostly clean	Of mixed sizes, dark coloured and dirty, and of poor appearance; some damaged kernels present

The samples of undecorticated nuts contained the following proportions of husk and kernel:

	Chinese variety. *Per cent.*	Gambia variety. *Per cent.*	Zaria variety. *Per cent.*
Husk	26	24	23
Kernel	74	76	77

The average weight of the kernels and the percentages of moisture and oil which they contained are shown in the following table, which also includes the acid values of the oil:

Sample.	Average weight of single kernel. *Grams.*	Moisture (on drying at 100° C.) *Per cent.*	Yield of oil from kernels as received. *Per cent.*	Acid value of oil.[1]
Chinese variety:				
Kernels from undecorticated nuts	0·78	7·2	43·7	2·5
Selected kernels	0·78	6·0	44·7	0·8
Unselected kernels	0·50	6·9	43·1	1·5
Gambia variety:				
Kernels from undecorticated nuts	0·42	6·9	45·6	1·0
Selected kernels	0·43	6·1	47·5	1·7
Unselected kernels	0·41	6·9	45·3	1·1
Zaria variety:				
Kernels from undecorticated nuts	0·58	7·7	43·3	2·3
Selected kernels	0·62	6·1	44·6	1·1
Unselected kernels	0·46	9·9	41·6	11·2[2]

[1] *Milligrams of caustic potash required to neutralise the free acids in one gram of oil.*

[2] *The high acid value of this sample was due to the presence of damaged kernels.*

It will be seen, from these results, that the yields of oil from the kernels varied from 41·6 to 47·5 per cent., the latter figure being given by the selected Gambia kernels. The percentages of oil are distinctly lower than the yields from previous specimens of ground-nut kernels from the Northern Provinces, Nigeria, which on examination at the Imperial Institute were found to contain from 44·9 to 49·0 per cent. of oil. In the present samples the selected kernels of each variety contained more oil than the unselected samples, the differences ranging from 1·6 to 3·0 per cent.

The acid values of the oil are low in all cases, except in that from the unselected Zaria kernels, indicating that the kernels were in good condition.

Samples of the undecorticated nuts and of the selected and unselected kernels were submitted for valuation to oil-seed crushers, who reported that the amount of oil in these ground nuts was in most cases distinctly below that generally found in the nuts from the Gambia, in the Rufisque variety grown in French territory, or in those usually shipped from Nigeria. The average percentage of oil in the West African kernels is about 48 per cent., and only one of the present samples (the Gambia selected kernels) gave a yield approaching this amount. At the prices for ground-nut oil obtaining at this time (April 1919), each extra unit per cent. of oil would represent an additional value to the crushers of 10*s.* per ton.

The firm stated that the Gambia variety is of the highest value for crushing purposes, but that in ordinary times the Chinese variety, as grown in China, commands a premium for confectionery purposes, on account of the large size and clean appearance of the kernels, although they are not so rich in oil. They added that there would be no difficulty in finding a market for any quantity of ground nuts represented by these samples.

Samples of the nuts were also submitted to brokers, who stated that, in their opinion, the unselected kernels, were too good to be representative of bulk consignments, and that, under the conditions of Government control then in force, there was no inducement to select ground

nuts, as the whole of the imports were sold to the crushers under the guarantee of " fair merchantable quality."

As already indicated, these three varieties of ground nuts from Ibadan were not of such good quality as samples from the Northern Provinces previously examined at the Imperial Institute. Such ground nuts would, however, be readily saleable in the United Kingdom for crushing purposes, but, owing to the distinctly low yields of oil, they would not realise the best prices under normal market conditions.

The selected kernels contained higher percentages of oil than the unselected, but it is not certain whether the increased price obtainable for the former under normal market conditions would be sufficient to make selection on a commercial scale remunerative.

SERIES II

These nuts, which were grown at the Moor Plantation in 1919, were forwarded in order to ascertain whether the low yields of oil observed in the previous series are a constant feature of the ground nuts grown at this plantation.

The samples consisted of clean, undecorticated ground nuts with unbroken husks. They represented the following varieties : " Zaria," " Chinese," " Gambia," " Erect " and " Hausa."

The " Chinese " and " Gambia " nuts differed somewhat in size and appearance from those previously examined (see p. 133), but the " Zaria " nuts were similar to the previous sample of this variety. The " Erect " and " Hausa " varieties had not been previously examined at the Imperial Institute.

The nuts were decorticated at the Imperial Institute, and the kernels examined with the following results, which are shown in comparison with the figures obtained for the previous samples of selected kernels of the " Zaria," " Chinese " and " Gambia " varieties :

	Average weight of kernels.	Moisture.	Yield of oil.		Acid value of oil.
			Expressed on kernels as received.	Expressed on moisture-free kernels.	
	Grams.	Per cent.	Per cent.	Per cent.	
Zaria :					
Present sample . .	0·66	5·7	45·4	48·1	0·56
Previous sample (selected kernels) . . .	0·62	6·1	44·6	47·5	1·13
Chinese :					
Present sample . .	0·43	5·5	48·8	51·7	0·30
Previous sample (selected kernels) . . .	0·78	6·0	44·7	47·6	0·83
Gambia :					
Present sample . .	0·54	5·9	45·5	48·3	0·55
Previous sample (selected kernels) . . .	0·43	6·1	47·5	50·6	1·70
Erect :	0·59	5·9	45·2	48·0	1·12
Hausa :	0·60	6·1	45·4	48·3	0·28

It will be seen from these figures that the "Zaria" kernels yielded a little more oil than those previously forwarded, whilst the "Chinese" kernels contained 4 per cent. more oil than the earlier sample. On the other hand, the yield of oil from the "Gambia" kernels was 2 per cent. less.

The "Erect" and "Hausa" varieties each yielded about 45 per cent. of oil from the kernels as received.

The oil from the "Chinese" kernels was of dark reddish-brown colour, which would detract from its value. These kernels, moreover, were of small size, and therefore not likely to be readily saleable for dessert or confectionery purposes.

The yields of oil from the present five samples ranged from 45·2 to 48·8 per cent. on the kernels as received, but only in one case (the "Chinese" kernels) did the yield exceed 45·5 per cent. The previous ground nuts from Ibadan yielded from 44·6 to 47·5 per cent., and samples from the Northern Provinces 44·9 to 49·0 per cent. of oil. The average yield of oil from commercial consignments of West African ground-nut kernels is, as already mentioned, about 48 per cent.

The results of the examination of these samples, therefore, tend to confirm the conclusions reached in the

previous investigation, that ground nuts grown at the Ibadan Station contain a rather low percentage of oil. On the whole, however, the nuts were of good quality, and would be readily saleable in the United Kingdom. The "Chinese" nuts were inferior to the previous sample of this variety, in being much smaller and in yielding a coloured oil, and they would therefore be less valuable.

Series III

This series comprised fourteen samples of clean, undecorticated ground nuts, representing varieties grown at the Moor Plantation in 1920. Two samples, marked "A" and "B," were furnished of each of the following seven varieties: "Chinese," "Erect," "Gambia," "Hausa," "Zaria," "Ayaya" and "Mache Atagune." The samples marked "A" were stated to represent the average quality of the nuts obtained from the field, whilst those marked "B" consisted of nuts taken from the parts of the field in which the plants had suffered most severely from "tikka" disease (*Cercospora personata*), which had attacked the crop. It was desired to ascertain the effect of this disease on the yield of oil from the kernels.

In the following descriptions the kernels of the nuts are compared with those of the corresponding samples included in Series II:

"*Chinese.*"—A. The kernels were in many cases shrivelled. In comparison with the previous sample of Chinese kernels they were longer, less plump, and inferior in quality.

B. The kernels were similar to those of sample A, but were plumper and more variable in size.

"*Erect.*"—A. The kernels were plump, but a number of them were dark in colour, and they were generally inferior in this respect to the previous sample of "Erect" kernels.

B. The kernels were similar in appearance to those of sample A, but smaller.

"*Gambia.*"—A. The kernels were plump, but uneven in colour, and inferior in this respect to and also smaller than the previous sample.

B. The kernels were similar to those of sample A.

"*Hausa.*"—A. The kernels were on the whole large and plump, only a few being shrivelled. They were superior in size to the previous sample, but inferior in colour.

B. The kernels were much inferior to those of sample A, and were of poor appearance, some being undeveloped, others shrivelled, and a few attacked by insects. The kernels varied in size, and were of inferior colour.

Table I

Variety.	Percentage of kernel.	Percentage of husk.	Average weight of a single kernel.
Chinese :			*Grams.*
Present sample (A)	76·0	24·0	0·54
,, ,, (B)	74·5	25·5	0·51
Previous sample . . .	77·5	22·5	0·43
Erect :			
Present sample (A)	75·0	25·0	0·53
,, ,, (B) . . .	77·0	23·0	0·44
Previous sample . . .	82·0	18·0	0·59
Gambia :			
Present sample (A)	79·0	21·0	0·47
,, ,, (B)	80·0	20·0	0·45
Previous sample . . .	75·5	24·5	0·54
Hausa :			
Present sample (A)	88·0	12·0	0·60
,, ,, (B)	73·0	27·0	0·50
Previous sample . . .	75·0	25·0	0·60
Zaria :			
Present sample (A)	76·0	24·0	0·60
,, ,, (B)	78·0	22·0	0·57
Previous sample . . .	74·0	26·0	0·66
Ayaya :			
Present sample (A)	81·0	19·0	0·60
,, ,, (B)	83·0	17·0	0·55
Mache Atagune :			
Present sample (A)	85·0	15·0	0·67
,, ,, (B)	85·0	15·0	0·75

"*Zaria.*"—A. The kernels were large, plump and of fairly good colour, being of a paler tint than the earlier sample.

B. The kernels were generally similar to those of sample A, but a few of them were shrivelled.

"*Ayaya.*"—A. The kernels were plump and of moderate size, and had pinkish-brown skins, except in the case of a few which were of darker colour.

B. The kernels were similar in appearance to those of sample A.

"*Mache Atagune.*"—A. The kernels were large, plump, and of a pinkish-brown colour. They were of lighter tint than a previous sample received at the Imperial Institute from the Northern Provinces.

B. The kernels were slightly larger than those of sample A, and darker in colour.

Table II

Variety.	Moisture.	Yield of oil.		Acid value of oil.
		Expressed on kernels as received.	Expressed on moisture-free kernels.	
	Per cent.	*Per cent.*	*Per cent.*	
Chinese :				
Present sample (A)	6·0	44·4	47·2	0·44
" " (B)	6·1	43·1	45·9	0·42
Previous sample	5·5	48·8	51·7	0·30
Erect :				
Present sample (A)	5·9	46·2	49·1	1·72
" " (B)	5·1	46·2	48·7	0·39
Previous sample	5·9	45·2	48·0	1·12
Gambia :				
Present sample (A)	5·5	45·4	48·2	0·37
" " (B)	5·3	44·8	47·3	0·34
Previous sample	5·9	45·5	48·3	0·55
Hausa :				
Present sample (A)	5·3	45·2	47·7	0·39
" " (B)	6·1	44·1	47·0	0·92
Previous sample	6·1	45·4	48·3	0·28
Zaria :				
Present sample (A)	5·7	44·9	47·6	1·22
" " (B)	5·2	44·0	46·4	0·98
Previous sample	5·7	45·4	48·1	0·56
Ayaya :				
Present sample (A)	5·7	46·0	48·8	1·40
" " (B)	5·7	44·7	47·4	0·66
Mache Atagune :				
Present sample (A)	5·6	46·1	48·8	1·03
" " (B)	5·6	46·0	48·7	3·70

The nuts were decorticated at the Imperial Institute and the proportions of husk and kernel, and the average weights of the kernels, are shown in Table I on p. 138. In the case of the first five varieties the corresponding figures for the samples in the second series are shown for comparison.

There was little difference between the kernels of the

several varieties in the two sets of samples A and B, except in the case of the "Hausa" nuts, in which the kernels of B were considerably inferior in quality to those of A.

The results of the chemical examination of the kernels are shown in Table II on p. 139, in comparison with the figures obtained with the previous samples of the first five varieties (see p. 136):

The yields of oil are fairly satisfactory on the whole, but in general they confirm the conclusion already expressed that ground-nut kernels from the Moor Plantation yield somewhat lower percentages of oil than is usual for West African kernels.

It will be seen that the yields of oil from the "B" samples were not much less than those from the "A" samples, so that the "tikka" disease had not had any serious effect on the percentage of oil in the kernels.

These ground nuts were on the whole of fairly good quality, and would be readily saleable. "Shelled Nigerian" ground nuts were recently quoted at £15 10s. per ton, and "unshelled Gambia" at £13 per ton in Liverpool (April 1921).

It was suggested by the Imperial Institute in April 1919 that, in view of the high yields of oil that had been obtained from samples of "Mache Atagune" and "Kano" ground nuts in the Northern Provinces, these varieties might be tried at the Moor Plantation. The "Mache Atagune" kernels grown at the Moor Plantation have, however, yielded less oil than those received from the Northern Provinces, which in one case furnished over 51 per cent. of oil from the moisture-free kernels. It would be of interest if further trials were made with this variety, and if the cultivation of the "Kano" nuts could also be tried, in order to ascertain definitely whether better results can be obtained with these varieties than with those which have been the subject of the previous trials.

ILLIPE KERNELS FROM BRITISH NORTH BORNEO

The illipe nuts of Borneo, Sumatra, and neighbouring islands, the source of Borneo tallow, now of importance

as an edible fat, are derived from various dipterocarp trees, of which *Shorea stenoptera*, Burck., is the most important. They are quite distinct from the illipi nuts of India, which are obtained from species of *Bassia* (natural order, Sapotaceæ). A full account of the different forms of Borneo illipe nuts, with the results of examination of a number of samples, will be found in this BULLETIN (1915, **13**, 335). A quantity of kernels has recently been forwarded from British North Borneo for investigation, and the results are given in the following pages.

The kernels were stated to have been obtained from nuts collected in the Kinabatangan district and washed in sea water.

The sample consisted of segments of kernel of varying size, measuring up to 1¾ in. in length. The segments were hard and dark reddish-brown, and many of them had been attacked by insects.

The kernels were found to contain 6·9 per cent. of moisture, and to yield, on extraction with light petroleum, 44·8 per cent. of fat, corresponding to a yield of 48·1 per cent. from the moisture-free kernels.

The fat was a greenish-yellow solid with a faint odour. It was examined with the following results, which are shown in comparison with those obtained with a previous sample of illipe fat examined at the Imperial Institute and with figures previously recorded for Borneo tallow:

	Present sample.	Previous sample.	Borneo tallow.
Specific gravity at 100/15° C.	0·8551	0·8516	0·8597
Refractive index at 40° C.	1·456	—	1·456–1·457
Solidifying point of fatty acids	52·5° C.	52·0° C.	49–51° C.
Melting point of fat	34·0° C.	37·0° C.	34–36° C.
Acid value [1]	11·4	46·5	—
Saponification value [1]	192·4	195·4	188–207
Iodine value, *per cent.*	32·2	31·5	29–38
Unsaponifiable matter, *per cent.*	0·6	0·2	0·7–2·0
Volatile acids, soluble [2]	0·1	0·5	—
Volatile acids, insoluble [2]	0·4	0·3	—

[1] *Milligrams of potash for 1 gram of oil.*
[2] *Cubic centimetres of decinormal alkali required to neutralise acid from 5 grams of oil.*

The residual meal left after the extraction of the fat from the kernels was yellowish-brown, and had a faint, bitter taste. The results of its analysis are shown in the

following table in comparison with figures previously recorded for "illipe cake":

	Present sample.	Figures recorded for "illipe cake."
	Per cent.	*Per cent.*
Moisture	10·9	12·20
Crude proteins	10·3	11·32
Fat	7·8	7·53
Carbohydrates, etc. (by difference)	64·5	55·35
Crude fibre	3·2	7·64
Ash	3·3	5·96
Nutrient ratio	1 : 8·0	1 : 6·4
Food units	110	102

The meal contained no alkaloids or cyanogenetic glucosides.

These illipe kernels represented the brown variety and contained 48 per cent. of fat in the dry material, which is about the usual yield, the recorded figures being from 48 to 53 per cent.

The fat had the usual composition and character of Borneo tallow. The acid value (11·4), though rather high for an edible fat, is a considerable improvement on the acid values of the previous samples examined at the Imperial Institute, which varied from 45 to 73.

The residual meal contained a rather low percentage (10·3) of protein, and would not be so valuable a foodstuff as palm-kernel cake, which usually contains 16 per cent. of protein. Illipe meal is, however, readily saleable in the United Kingdom.

GEMSBOK BEANS FROM SOUTH AFRICA

THE seeds of the leguminous plant, *Bauhinia esculenta*, have been examined recently at the request of the Chief, Division of Botany, Union of South Africa.

It was stated that the seeds, which are known locally as Gemsbok beans, are utilised both for native consumption and for feeding to animals in the South-West Protectorate, and it was desired to ascertain their precise food value and whether they contain any injurious substance.

The seeds were dark reddish-brown in colour, about ½ to ⅝ in. in diameter, and possessed woody shells and

cream-coloured oily kernels. The kernels had a pleasant, nutty flavour, but were slightly bitter.

The seeds were composed of shell, 49 per cent., and kernel, 51 per cent. The average weight of a single bean was two grams and of a kernel one gram.

The following table gives the results of the chemical examination of the shells, kernels and entire seeds.

	Kernels. *Per cent.*	Shells. *Per cent.*	Entire seeds. *Per cent.*
Moisture	4·0	8·5	6·2
Crude proteins	32·8	2·5	18·0
Fat	41·6	0·2	21·3
Carbohydrates, etc. (by difference)	17·2	67·2	41·6
Crude fibre	1·3	19·8	10·4
Ash	3·1	1·8	2·5
Nutrient ratio	1 : 3·4	1 : 27·1	1 : 5·0
Food units	203	74	140

The seeds contained no alkaloids or cyanogenetic glucosides.

The kernels of the seeds contained 4 per cent. of moisture, and on extraction with ether yielded 41·6 per cent. of a golden-yellow, limpid oil, equivalent to a yield of 43·3 per cent. of oil from the moisture-free kernels. The oil thus extracted, which had a pleasant odour and taste, furnished the following constants, which are shown in comparison with corresponding figures for cotton-seed oil:

	Gemsbok-bean oil.	Cotton-seed oil.
Specific gravity at 15/15° C.	0·9211	0·922–0·925
Refractive index at 40° C.	1·464	—
Solidifying point of fatty acids	30·6° C.	35°–38° C.
Acid value	0·6	—
Saponification value	190·0	192–195
Iodine value, *per cent.*	95·6	105–115
Unsaponifiable matter, *per cent.*	0·8	0·8–1·8
Volatile acids, soluble	0·3	—
" " insoluble	0·1	—

These results show that the oil from Gemsbok seeds is similar in its constants to cotton-seed oil.

The composition of the residual meal left after the extraction of the oil from the kernels (calculated for meal containing 7 per cent. of fat) is shown in the following table, which also includes the figures for decorticated cotton-seed cake for comparison:

	Gemsbok-bean meal.	Decorticated cotton-seed cake.
	Per cent.	*Per cent.*
Moisture	6·4	8·65
Crude proteins	52·2	40·25
Fat	7·0	7·93
Carbohydrates (by difference)	27·4	26·06
Crude fibre	2·1	10·16
Ash	4·9	6·95
Nutrient ratio	1 : 0·83	1 : 1·1
Food units	175	147

The results of this investigation show that the kernels of Gemsbok seeds are rich in protein and oil, and that the oil resembles cotton-seed oil. The oil would probably be suitable for edible use, and might prove slightly superior to cotton-seed oil for this purpose. The meal left after extraction of the oil contains a high percentage of protein and a low percentage of fibre, and in these respects is superior to decorticated cotton-seed cake.

No injurious substance was found in the seeds, but, if it has not been definitely established that they are harmless, it would be advisable to carry out feeding trials before definitely recommending them for general use as a feeding-stuff. For this purpose the hard shells should be removed, as they are woody and of low food value.

No previous information appears to be on record regarding the composition of Gemsbok seeds or their use as a feeding-stuff, but the seeds of certain species of Bauhinia are stated to be employed as food in India. If available in sufficient quantities these Gemsbok seeds seem likely to be of value both as a foodstuff and as a source of oil.

CHARACTERS AND USES OF CUICA RESIN

In a previous number of this Bulletin (1919, **17**, 296) an account was given of the examination of "cuica" or "quika" resin, which is derived from *Cercidium spinosum*, Tulasne, a small tree native to Colombia, South America. The results indicated that the material was inferior to other resins for the preparation of spirit, turpentine, or oil varnishes, but in order that conclusive trials might be made a further supply was obtained from Colombia last year.

The material received consisted of pale yellow resin in a somewhat coarsely ground condition. It was generally similar to that previously examined, but contained a rather larger proportion of bark.

The resin as received was examined at the Imperial Institute with the following results, which are shown in comparison with those recorded for the previous sample:

	Present sample. *Per cent.*	Previous sample. *Per cent.*
Moisture	2·1	1·3
Matter insoluble in boiling alcohol[1]	15·3	8·1
Matter soluble in boiling alcohol (resin)	82·6	90·6
Ash	2·1	3·0

[1] *Consisting chiefly of bark.*

The resin was submitted to a firm of varnish manufacturers who had expressed a wish to test it in the manufacture of cold lacquers and crystal varnishes. After carrying out practical trials the firm reported that the results were not very satisfactory, as the solubility of the resin in turpentine was low and the film left on evaporation of the solvent did not harden for several days. The results confirmed their previous opinion that the resin could not be employed in the preparation of oil varnishes, and they considered that the only possible use to which it could be put would be in the preparation of thin lacquers, for which benzol or similar solvents could be used. Such lacquers made from Cuica resin would, however, be of rather inferior quality and unlikely to offer any advantages over many other lacquers at present in use, and on this account the Cuica resin would have to be offered at a price between those of Manila resin and common rosin (about £1 to £2 per cwt., May 1921), the value depending on the purity of the material.

The results of the present investigation confirm the earlier opinion that this resin is not of very promising character for the manufacture of varnish, and it appears doubtful whether it could be sold remuneratively in the United Kingdom in competition with the better materials already available.

COTTON AND MANGROVE BARK FROM THE GAMBIA

THE cotton and mangrove bark which form the subject of this report were collected by Mr. M. T. Dawe during his recent tour in the Gambia. A summary of his *Report* on the tour will be found on pp. 207–211 of this BULLETIN.

COTTON

Two samples of seed-cotton were received at the Imperial Institute in February 1921.

A. *Cotton from Foni Province.*—In this case the lint was soft and lustrous, and varied from white to cream in colour. Some immature fibre was present. The yield of lint on ginning was 25 per cent., the yield per 100 seeds being 2·1 grams.

The seed was black, mostly covered with white fuzz. A few immature seeds and seeds devoid of fuzz were present.

The cotton was of irregular strength, a large proportion of it being rather weak. It varied in length from 0·8 to 1·2 in., being mostly from 0·9 to 1·1 in., with an average of 1·0 in.

The ginned cotton was valued in Liverpool at nominally about 7·87*d.* per lb. with "middling" American cotton (March futures) at 6·87*d.* per lb. It was of similar grade to "good middling Upland" and quite suitable for the United Kingdom market.

B. *Cotton from MacCarthy Island Province.*—The lint from this seed-cotton was soft, white and lustrous, but was rather badly stained and contained a fair amount of immature fibre. The yield of lint on ginning was 23 per cent., and the yield of lint per 100 seeds, 1·8 grams.

The seeds were black; about half of them bore white fuzz, whilst the remainder were devoid of fuzz. A few immature seeds were present.

The strength of the cotton was good on the whole, but somewhat irregular. The length varied from 0·7 to 1·1 in., being mostly from 0·8 to 1·0 in., with an average of 0·9 in.

The ginned cotton was valued at Liverpool at nominally

about 6·37*d.* per lb. with "middling" American (March futures) at 6·87*d.* per lb. Like sample A, it was of similar grade to "good middling Upland," but it was inferior to A owing to the presence of stained fibre.

It was suggested by Mr. Dawe that these cottons are the product of plants originally derived from Egyptian and American seed introduced into the Colony many years ago, and that the plants have degenerated owing to unfavourable conditions and inadequate cultivation.

The ginning yields (25 and 23 per cent. respectively) are abnormally low for Egyptian and American cottons; but this may be due to the degeneration of the plants.

Mangrove Bark

A sample of mangrove bark derived from *Rhizophora racemosa* was received in February 1921. It was in pieces from 3 to 5 in. in length, brownish-red in colour, with a thin, grey outer layer, and was clean and in good condition.

The bark was analysed with the following results:

	Per cent.
Moisture	9·5
Insoluble matter	49·9
Extractive matter (non-tannin)	19·3
Tannin	21·3
Ash	5·5
Tintometer readings, Red	7·1
" " Yellow	25·4

The bark yielded a firm, fairly soft leather of good texture and of pale brown tint.

This mangrove bark from the Gambia contained a rather higher percentage of tannin than several samples from West Africa previously examined at the Imperial Institute, but the amount was much lower than that present in the ordinary mangrove barks of commerce, viz. from 30 to 40 per cent. A low yield of tannin appears to be characteristic of the mangrove barks of West Africa, which are almost invariably of poor quality in comparison with those obtained from British and Portuguese East Africa.

The present sample yielded a paler coloured extract than is usual with mangrove barks and produced leather

of very good quality. In view, however, of the low yield of tannin, bark of similar character would not be worth exportation to Europe, and the high proportion of non-tannin extractive matter which it contains would render it unsuitable for the manufacture of extract.

REPORTS BY THE IMPERIAL INSTITUTE COMMITTEE ON TIMBERS

NEW ZEALAND TIMBERS

I. Kauri Pine

Report on Increased Utilisation in the United Kingdom

At the request of the Imperial Institute Committee for New Zealand, the Advisory Committee on Timbers of the Imperial Institute have enquired into the possibility of increasing the use of Kauri pine in this country. Their report is as follows :

Exports

The following tables indicate the amount and destination of the exports of Kauri pine from New Zealand for the years 1913, 1914 and 1915. Prior to 1913 exports of Kauri pine were not shown separately in the official trade returns of New Zealand.

Exports of Kauri Timber from New Zealand

	1913.		1914.		1915.	
	Sup. ft.	£	Sup. ft.	£	Sup. ft.	£
Total . .	10,265,470	91,421	15,629,552	131,454	11,608,767	97,036
To:						
United Kingdom	535,528	6,284	2,010,358	22,065	1,275,187	14,528
Australia .	9,216,635	77,376	12,101,800	97,480	8,833,498	70,620
Fiji . .	183,780	2,892	892,328	6,580	1,135,571	7,985
German Samoa	130,522	2,073	102,834	1,591	116,375	1,840
Other countries[1]	199,005	2,796	522,232	3,738	248,136	2,063

[1] *Tonga and the Society Islands were the most important.*

The following table shows the percentage exports to the chief countries :

—	1913.		1914.		1915.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
United Kingdom	5·2	6·9	12·9	16·8	10·9	15·0
Australia	89·8	84·6	77·4	74·2	76·1	72·7
Fiji	1·8	3·1	5·7	5·0	9·8	8·2
Other countries	3·2	5·4	4·0	4·0	3·2	4·1

Imports into the United Kingdom

Practically the whole of the Kauri sent to Europe comes to the United Kingdom and enters the ports of London, Liverpool and Glasgow, a smaller quantity being sent to Hull. The first cargoes of Kauri pine sent to Great Britain reached this country about 1888. London and Liverpool take the major part. The imports average about one entire sailer cargo (200 to 400 standards) per annum to each of the three principal ports as well as a number of parcels shipped by steamer.

The Committee understand that hitherto the supply has been fully equal to the demand, and that the stocks on hand have usually been sufficient for more than one year's consumption. Speaking generally, it is probable that with a larger demand supplies would have been increased, but the high price of Kauri, as compared with that of American and North European timbers, consequent upon the relatively heavy freight charges, has resulted in the use of the wood being restricted to special purposes.

Prices during the last twenty years have varied from 2*s*. 6*d*. to 4*s*. 6*d*. per cubic foot c.i.f. for cargoes of 200 to 400 standards. Parcels by liners have usually secured higher prices.

Uses of Kauri

In view of its remarkably homogeneous nature and freedom from heart-shake, sap or knots, Kauri is used for special purposes where these qualities are essential. Further, the wood is especially useful on account of the

great widths obtainable clear of heart, which command high prices. Flitches measuring 6 in. thick by 36 in. wide are often seen in a cargo specification.

The quantity of Kauri exported to Europe depends largely on the Australian demand, since in Australia the wood is employed for many purposes for which it could not be used in this country in competition with woods imported from the Continent and America at lower transport charges. Hence, practically only "clear" Kauri finds its way to Europe. Australia, however, uses all qualities of the timber, and will probably always be the principal market for Kauri. The relative importance of the Australian trade is well shown in the statistics quoted above. The Committee have ascertained that in Europe the principal uses to which Kauri is put are the following:

Brewers' Vats and Vessels.—The close grain, freedom from knots and cracks, and non-absorbent qualities of the wood make it especially suitable for these purposes.

Ship-building.—Kauri is the best wood for deck planking in view of its close grain and hard wearing qualities. Moreover, Kauri decks present a very good appearance where such is necessary, as in passenger ships and yachts. The timber is stated to shrink lengthwise, and this is doubtless the case when used in an unseasoned state, but if the planks are properly seasoned and the ends are painted with varnish, glue or similar compound, thereby sealing the ends, this defect may be entirely obviated. As yellow pine is now almost unobtainable in the clean quality necessary for decking, Kauri is the only substitute where decks are required free from knots.

Kauri is also used for boat-building, and when polished is successfully used for panelling in the interior fittings of liners.

High-class Joinery; Railway and other Carriage Work.—Kauri is eminently suitable for joinery work of the highest class on account of its soundness, freedom from knots, and clean working under machine tools. Many of the large railway companies use Kauri for the interior fittings of carriages, the excellent finish resulting from french-polishing and varnishing making it very suitable for this purpose. The wood also takes paint well.

Certain companies also use the wood for cutting semi-circular "sweeps" to support the roofs of the carriages. Owing to its great width such sweeps can be economically cut and the special bending of timber is thus avoided. Carriage builders employ Kauri as a substitute for birch for boot-sides and van-sides, on account of its good widths.

High-class Floors.—Kauri is very suitable for the floors of skating rinks and ballrooms, and for other floors of the highest class, as it is very tough in wearing and does not easily splinter under friction.

Engineers' Pattern-making.—Mild-natured planks can be selected for this purpose, the wood being specially valuable where particularly fine cutting is necessary.

Patent Stills.—As the wood can bear high steam temperatures, it is very suitable for these appliances.

Supplies

The Committee understand that the remaining Kauri forests are gradually becoming exhausted, and relatively less accessible. The Committee also gather that the rivers of New Zealand are often unsuitable for floating big logs, and railways are not easy to build, chiefly owing to the nature of the country. They consider that the questions of afforestation and the conservation of existing supplies of Kauri pine merit the fullest attention of the Dominion Government.

Summary

The excellent qualities and large available sizes of New Zealand Kauri pine render it a most valuable timber for a great variety of purposes. The Committee are agreed that the use of Kauri in this country could be largely extended, but the controlling factor must always be that of price, especially in relation to that of certain cheap hardwoods, notably West African mahogany, which are often used in competition with Kauri. In close association with this question of price is that of the availability of supplies of the timber in New Zealand.

December 1917.

II. First Report on the Commercial Uses of New Zealand "Birch" (Beech) Timbers (Fagus spp.) in the United Kingdom

The question of the utilisation in this country of the so-called "birch" timbers of New Zealand was referred to the Advisory Committee on Timbers by the Imperial Institute Committee for New Zealand, and their report is as follows:

So far as can be ascertained, New Zealand "birches" have not been introduced hitherto on the English market. The Committee consider that if the introduction of the timbers into this country is contemplated, it is of primary importance that the nomenclature of the woods should be carefully standardised. Botanically, the trees yielding the timbers are beeches (species of *Fagus*), and confusion is likely to result if the timbers are marketed as "birches," especially as each timber is stated to receive different names in the various districts in which it occurs. The recommendation made in the Report of the Royal Commission on Forestry in New Zealand (1913) that a standard description of the timbers, in agreement with their botanical origin, should be adopted to the exclusion of all others in publications, advertisements and tenders of all Government Departments of the Dominion is therefore to be strongly approved. The Committee understand it was proposed that the misleading term "birch" should be abandoned, and the following names adopted for the three principal commercial timbers: Red Beech (*Fagus fusca*); Black Beech (*Fagus Solandri*); Silver Beech (*Fagus Menziesii*).

These three timbers (especially Silver Beech) are stated to be coming steadily into use in New Zealand and Australia. Silver Beech is understood to be used to an increasing extent for furniture making, for which purpose it is said to be excellent. Red Beech is also stated to be used in New Zealand for railway sleepers.

The Committee have examined samples of Red Beech from the New Zealand Court at the Imperial Institute. They regard this species as a compact timber of good appearance and strength, which would probably be found suitable in this country for some of the purposes for which

Canadian birch (*Betula* sp.) is utilised. This wood is largely imported for making packing-cases for the tinplate industry, and for the cheap furniture trade; and is also used for cabinet-making, bobbins, spools, tool-handles, and turnery. The Committee also consider that New Zealand Red Beech might be found useful for wagon building. It is probably too heavy for the present type of aeroplane.

As regards prices, the usual pre-war price for ordinary Canadian birch varied between 1*s*. and 1*s*. 6*d*. per cubic foot, wholesale, somewhat higher prices up to 2*s*. being sometimes obtained for better qualities and larger widths. The Committee are of opinion that New Zealand beech would scarcely command more than this value, which it is feared would hardly prove remunerative.

June 1918.

III. Second Report on the Commercial Uses of New Zealand "Birch" (Beech) Timbers (Fagus spp.) in the United Kingdom

In their previous report dated June 1918 the Timbers Committee dealt with the general question of the commercial possibilities of New Zealand "birch" (preferably "beech") timbers in the English market, where, so far as the Committee are aware, these woods are practically unknown. In particular, the Committee submitted their views regarding the prospects of Red Beech (*Fagus fusca*).

In response to a request by the Committee, the New Zealand Government arranged for the despatch to the Imperial Institute of samples of Black Beech (*F. Solandri*) and Silver Beech (*F. Menziesii*) for examination and report. In a memorandum received at the Imperial Institute through the High Commissioner, the New Zealand Government expressed the view that, unless New Zealand beech can be found suitable in England for special purposes and command a special price, it would not pay to export the wood to this country in view of the fact that the price realised in New Zealand is 23*s*. per 100 superficial feet.

At the instance of the New Zealand Government, specimen planks of Southland or Silver Beech (*F. Men-*

ziesii) have been received from the Southland and Otago Co-operative Timber Co., Ltd., Invercargill, New Zealand. This Company has also furnished the Imperial Institute with particulars of the local uses of Southland Beech, and results of mechanical tests on the timber carried out at the Engineering School of Melbourne University, together with a list of prices per 100 superficial feet f.o.b. Bluff (September 1919). The prices in question are as follows:

	First quality.		Second quality.	
	s.	*d.*	*s.*	*d.*
Up to 5 inches wide . . .	22	0	19	0
" " 8 " " . . .	23	0	20	0
" " 10 " " . . .	25	0	21	6
" " 12 " " . . .	26	6	23	0

Widths over 12 inches, 1*s.* per inch extra.

A specially selected bending quality of the wood is supplied at 3*s.* per 100 superficial feet extra on the first quality prices.

As the result of their examination of the sample planks the Committee are of the opinion that the wood is of excellent general quality, possessing a fairly good grain and texture, but having no specially attractive appearance or character. In certain of the samples sent the heart portion of the plank is darker in colour than the remainder, and the Committee consider that this feature would be a disadvantage in using the wood for furniture-making or for any purpose where appearance is of importance.

As regards the uses to which Southland Beech might be put in this country, the Committee consider that it could be usefully employed for most purposes where Canadian (Quebec) birch is used, *e.g.* furniture, cabinet work, carriage building, bobbins, turnery, brush backs, and also for packing-cases for the Welsh tin-plate industry. It is unlikely, however, that the wood could be used as a substitute for English beech, which is specially suited for the purposes for which it is employed.

Recently the Imperial Institute has been consulted by firms of boot-last manufacturers in Northampton as to woods suitable for trial as substitutes for American rock-maple for making boot-lasts, in view of the increasing difficulty of obtaining adequate supplies of rock-maple

in this country. The question was referred to the Timbers Committee, who have suggested Southland Beech (among other woods) as worth trial. The Imperial Institute has therefore approached the Southland and Otago Co-operative Timber Co., Ltd., as to their willingness to supply a number of sample blocks of the wood for practical trial in Northampton.

In marketing New Zealand timber in this country the controlling factor is the price at which it can be landed. The Committee have had before them the figures mentioned by the Government of New Zealand as referred to above, and also those furnished by the Southland and Otago Co-operative Timber Co., Ltd. To these prices must be added the cost of freight, insurance, landing charges, and other expenses. Little or no freight space for timber from New Zealand to this country appears to have been available since October 1919, when the freight rate charged on Kauri pine was about 3*s*. 4*d*. per cubic foot. If this amount is added to the prices quoted by the Southland and Otago Co-operative Timber Co., Ltd., for September 1919, together with additional costs of insurance, etc., the cost of Southland Beech landed in this country amounts to about 7*s*. per cubic foot for widths up to 10 inches. At the present time (December 1, 1920) Quebec Birch is quoted in Liverpool at 6*s*. 6*d*. to 8*s*. per cubic foot.

In these circumstances the Committee suggest that, if it is desired to test the market in this country, a trial shipment of seasoned Southland Beech and of Red and Black Beech, if considered feasible, should be consigned to a firm of brokers with instructions to advertise the timber widely among persons likely to be interested in it, and finally to sell the consignment by public auction. By this means the prospects and prices of the timbers in this market at the present time will be ascertained.

December 1920.

IV. Report on the Preservation of Timber from Attacks by Boring Insects

The question of the possibility of preserving from attack by boring insects timbers already *in situ* in New Zealand buildings, which was referred to the Advisory Committee

on Timbers by the Committee for New Zealand, has been considered by the Timbers Committee, who have made the following report.

In dealing with this question it has been assumed that the insects concerned are the wood-boring Anobiid beetles, of which the death-watch beetle (*Anobium domesticum*) is perhaps the best known example. This beetle is reported as having attacked the Museum building at Canterbury, New Zealand, and it is possible that the damage referred to by the Committee for New Zealand may also have been caused by this species.

In general, the damage is done by the beetle when in the larval (grub) stage. This stage may extend over one or more years, and the subsequent pupal (or chrysalis) stage is often a year or more in duration before the perfect beetle emerges. If feasible, inspection of the timber structure of a building, with a view to the detection of the insects as early as possible, is therefore desirable if it is known or suspected that the timber is attacked.

The extermination of beetles in affected timber already *in situ* in buildings is recognised as a very difficult problem. The methods suggested aim chiefly at the destruction of the grubs or beetles by the use of poisonous fluids or gases applied to the affected timber. In cases where the grubs are relatively near the surface such methods may be effective, but, since the larvæ are commonly deeply embedded in the timber before remedial measures are adopted, much practical difficulty is experienced in effecting adequate penetration of the insecticide. The great vitality of beetle larvæ is a further factor in the situation.

If the expense involved is not too great, surface washing or spraying would appear to be the most practicable method of treatment for timber in ordinary buildings, provided that an insecticide of sufficient penetrative power can be obtained and the process carried out as thoroughly as possible. Preparations of creosote oil and a saturated solution of naphthalene in carbon tetrachloride have been suggested for this purpose. It is considered, however, that the former would probably fail to penetrate wood to any considerable depth, and their colour, odour,

and inflammability are objections to their use, especially for the interiors of buildings.

As regards the naphthalene solution, naphthalene is a powerful insecticide, cheap, and readily soluble in carbon tetrachloride, which is itself insecticidal. The fumes should not be inhaled. It is stated, however, that the full value of this solution can only be obtained if it is applied under great pressure. Further, there is the drawback that the naphthalene would render the timber more inflammable.

Much experimental work on the subject has been carried out in connection with the enquiry [1] into the damage done to the oak roof of Westminster Hall by the Anobiid beetle, *Xestobium tessellatum*. The methods tested in this investigation may be grouped under the following headings: (*a*) heat, (*b*) pressure, (*c*) spraying, (*d*) impregnation by liquids under pressure, (*e*) surface washing or painting with insecticides.

As regards insecticidal liquids the conditions to be fulfilled were that any fluid adopted should not contain any highly inflammable ingredients or materials so poisonous as to involve serious risk to workmen; and that it should not darken the characteristic orange-brown colour of the roof timbers.

The solution finally adopted was as follows:

	Per cent.
Orthoparadichlorbenzene	91
White Castille soap [2]	7
Cedar-wood oil [2]	2

This mixture, although a powerful insecticide, is non-poisonous to human beings. It was applied with a hose and spray nozzle by means of a hand-pressure pump capable of working up to a pressure of 120 lb. per square inch. The fluid, however, was sprayed at an actual pressure of from 20 lb. to 60 lb. per square inch, the nozzle

[1] *Westminster Hall. Report to the First Commissioner of H.M. Office of Works, etc., on the Condition of the Roof Timbers of Westminster Hall, with Suggestions for maintaining the Stability of the Roof.* By Mr. F. Baines, M.V.O., one of the principal Architects in H.M.O. Works, 1914 (Cd. 7438). The Committee has also had access to a further report on this question through the kindness of Sir Frank Baines, K.B.E., M.V.O.

[2] *Any pure soap could be used in place of white castille soap; and eucalyptus oil substituted for cedar-wood oil.*

being held as close to the timber as practicable to effect a maximum penetration. Every part of the timber received two good soakings. Before treatment, however, it is essential that the timber should be thoroughly brushed to remove all dust and débris, including that in the bore-holes of the insects. An ordinary vacuum cleaner would be useful for the latter purpose.

Sufficient time has not yet elapsed to enable an opinion to be formed as to the probable efficiency of this treatment, the results of which will be watched with much interest.

As regards preventive measures, it may be stated that the absence of free ventilation is considered as increasing the liability of timber to insect attack. Further, only thoroughly sound timber should be employed, and sap-wood avoided whenever possible. The observations of Mr. R. Speight, Curator of the Canterbury Museum, New Zealand, are of importance. It has been ascertained that, while many New Zealand timbers are subject to attack by the boring beetle *Anobium domesticum*, others appear to be more or less immune. Lists of the more important timbers of these two classes are appended to this report (page 160).

For new buildings it would thus appear advisable to use as far as possible Kauri, Rata, and other timbers mentioned in List No. 2. If, however, it is necessary or desirable to use White Pine, Rimu, Totara, Matai, or other timbers liable to attack by *Anobium domesticum*, only sound, thoroughly seasoned heartwood should, if possible, be employed.

If the ravages of the beetles in New Zealand are very serious the question of treating with a preservative timber intended for new buildings might be considered, due account being taken of the additional cost of such treatment and its possibly objectionable nature. For sound timber, free from insect eggs or pupæ, a surface dressing might be sufficient. If discoloration of the wood, and a certain exudation and smell of creosote, lasting for some years, are not prohibitive (as would be the case for interior work), ordinary creosote or one of the well-known special preparations of creosote oils might be tried for this purpose. The full value of these materials is obtained by the impreg-

nation of the wood in the form of joists, scantlings, etc., either by the "open tank" or the "pressure" processes, both of which need expert supervision and special plant. Their use, however, unfits the wood for painting and varnishing, and increases its inflammability. The ortho-paradichlorbenzene solution, referred to above, might also be tried for preventive treatment. In using such solutions it should be borne in mind that the degree of actual penetration is often comparatively small. If the timber has been treated on all surfaces, however, it will remain resistant to insect attack if the surfaces remain free from cracks or splits. If sufficiently deep the latter will expose a surface to which the solution has not penetrated, thus offering an opening for attack by the beetles. So far as practicable, therefore, important timbers in a building should receive a further dressing with insecticide if and when checks and splits occur.

The treatment of the timber (before use) by the powellising process, as adapted for wood exposed to attack by white ants, is also worth consideration. In this case arsenic is added to the usual saccharine solution. Powellising does not increase the inflammability of the timber, nor prevent the use of paint. The Committee understand that the New Zealand Powell Wood Process, Ltd., possesses works in New Zealand at Rangataua, and the question of approaching the company as to the resistance to insect attack of New Zealand timbers which have been "powellised" might be considered.

Lime-whitening of timber is regarded in this country as of value in preserving timber from attack by insects; and a surface dressing of a solution of corrosive sublimate in methylated spirit is sometimes employed for the same purpose. The inflammable and extremely poisonous nature of this latter fluid, however, and the facts that it is expensive and corrodes iron, are points strongly in its disfavour.

APPENDIX

List No. 1

New Zealand Timbers subject to attack by Anobium

Tawa (*Beilschmiedia Tawa*)
Rimu (*Dacrydium cupressinum*)
Monoao (*Dacrydium Colensoi*)
Hinau (*Elaeocarpus dentatus*)
Kotukutuku (*Fuchsia excorticata*)
Ribbonwood (*Hoheria populnea*)
Kawaka cedar (*Libocedrus Doniana*)
Red beech (*Fagus fusca*)
Silver beech (*Fagus Menziesii*)
Black beech (*Fagus Solandri*)
Toatoa (*Phyllocladus trichomanoides*)
White pine[1] (*Podocarpus dacrydioides*)
Matai,[1] black pine (*Podocarpus spicatus*)
Totara (*Podocarpus Totara*)

List No. 2

New Zealand Timbers apparently immune

Kauri (*Agathis australis*)
Titoki (*Alectryon excelsum*)
Akeake (*Dodonaea viscosa*)
Kohekohe (*Dysoxylum spectabile*)
Lacebark (*Gaya Lyallii*)
Rewarewa (*Knightia èxcelsa*)
Manuka (*Leptospermum scoparium*)
Mahoe (*Melicytus ramiflorus*)
Mountain rata (*Metrosideros lucida*)
Rata (*Metrosideros robusta*)
Pohutukawa (*Metrosideros tomentosa*)
Mapau (*Myrsine Urvillei*)
Black maire (*Olea Cunninghamii*)
Tawhiwhi (*Pittosporum tenuifolium*)
Lacebark (*Plagianthus betulinus*)
Black pine (*Podocarpus ferrugineus*)
Kowhai (*Sophora tetraptera*)
Towai (*Weinmannia racemosa*)

[1] Stated to be badly attacked (where sapwood used) in the Canterbury Museum.

January 1920.

SPECIAL ARTICLE

THE DECLINE IN THE YIELD OF EGYPTIAN COTTON AND ITS CAUSES

By Gerald C. Dudgeon, C.B.E., *lately Consulting Agriculturist to the Government of Egypt*

The decline in cotton production in Egypt is a subject which has received the constant attention of industrial and economic critics for the last twenty years. Although, in the main, contributors to the discussion have usually correctly indicated the chief causes to which this decline is due, the proportionate share of each in the result is often so unduly emphasised by them as to produce an

incorrect impression. This, together with their failure to recognise the origin of the evils and the true value of the effects of such remedial measures as have been tried, is apt to give rise to prejudice and lead to the adoption of incorrect procedure. In this short article an endeavour is made to draw attention to some points which seem to have been generally overlooked, and to correct, if possible, some conclusions which appear to have been arrived at on insufficient grounds.

The chief accepted reasons for the decline in cotton production per acre in Egypt will be referred to categorically in the first place, as, by so doing, they can hereafter be employed conveniently as headings for independent criticism. The factors influencing the yield per acre may be considered for this purpose to fall under three important headings, as follows :

1. Degeneration of the productive powers of the soil, due to :

(*a*) Excessive cultivation of cotton in proportion to other crops in the rotation employed ;

(*b*) Rise in the water table in the Delta by reason of the increased canalisation of the land and lack of adequate contemporary drainage ;

(*c*) Insufficient supply of manures and fertilisers to meet the increased call upon the soil, especially during the last few years, and the introduction of noxious substitutes.

2. Ravages of insect pests and the extensive employment in consequence of a variety of cotton with an earlier maturity but lower productive powers.

3. Agrarian disturbance.

Before considering these matters and commenting upon each independently, it may be useful to have before us the available figures, showing the presumed production of former as well as of recent years, in order to show the basis from which the discussion regarding the decline has arisen. This may be looked upon as the more necessary because there is a question of the accuracy attached to the results given for the period during which the maximum average yields are recorded—a point frequently overlooked.

In the table on page 163 the first column shows the year of cultivation, and the second the percentage area planted with cotton in the total cultivated area of the country in each year. It should be remarked with reference to the latter, however, that, though these figures are often cited, they give an incorrect idea of the frequency in which cotton occurs in the crop rotation, because in the area denoted as the total under cultivation (approximately 5,621,000 feddans) is included about 1,108,000 feddans of basin cultivation, in which it is not possible to grow cotton (except to an insignificant extent in the vicinity of wells) owing to lack of summer water. To arrive at a figure, therefore, which shall be usefully indicative of the proportionate area of cotton planted each year in the perennially irrigated cotton-growing area of the country, we must adopt the expedient of multiplying the figures in the second column by $\frac{5}{4}$, which will give an approximately correct result. The equivalents of these calculations are given in italics in the third column. Column IV supplies the actual percentage area of cotton planted each year from 1905 in the Delta, or Lower Egypt, in relation to the total cultivated area of that portion of the country. Column V gives the average yields of cotton in kantars per feddan per annum, based on the annual official computation of cotton areas, and the amount of cotton reaching Alexandria between the 1st of September of the year of cultivation and the 31st of August of the following year.

The subject of the official returns of cotton areas is one which will be referred to later, but, in respect to the method of establishing the year's crop, it should be mentioned that this does not necessarily represent the true production of one season. On occasions, for example when the market-price is steadily falling, much cotton is doubtless carried over until the next season, or even later. Notwithstanding this, for practical purposes, and because there is no other more effective means of ascertaining the year's production, the method is generally accepted as affording a sufficiently accurate approximation of the crop of the particular year it is supposed to represent. Column VI in the table gives notes concerning the times

when alterations were made in water supply, furnishes the dates of Cotton Commissions of Enquiry, and other events of interest.

In the table the following equivalents are used: One feddan, or Egyptian acre = 1·038 English acres; one kantar = 99·05 lb.

I. Year.	II. % cotton to total cultivation area.	III. % cotton to perennially irrigated area.	IV. % cotton to cultivation area in Delta.	V. Crop in kantars per feddan.	VI. Remarks.
1894	20·01	25·1	—	4·78	
1895	20·4	25·5	—	5·27	Third Cotton Commission
1896	20·2	25·2	—	5·60 Mean	
1897	22·3	27·9	—	5·80 5·34	
1898	22·0	27·5	—	4·98	
1899	22·2	27·7	—	5·64	
1900	23·5	29·4	—	4·42	Delta Barrage held 14 metres
1901	23·7	29·6	—	5·10	Barrage held more water
1902	23·9	29·9	—	4·58 Mean	
1903	25·5	31·9	—	4·88 4·53	Assouan Reservoir commenced supply
1904	26·7	33·4	—	4·39	
1905	28·9	36·1	39·7	3·80	
1906	28·0	35·0	40·2	4·61	
1907	29·6	37·0	40·4	4·51	
1908	30·8	38·5	40·9	4·12	Fourth Cotton Commission
1909	29·7	37·1	42·5	3·13 Mean	
1910	30·7	38·4	42·7	4·57 4·26	Fifth Cotton Commission
1911	32·5	40·6	44·5	4·31	
1912	32·5	40·6	44·3	4·35	Sixth Cotton Worm Commission
1913	32·6	40·7	43·9	4·45	
1914	34·9	43·6	45·4	3·67	Much of crop abandoned in the fields
1915	22·3	27·9	30·8	4·02	Area reduced
1916	31·9	39·9	42·8	3·06	War conditions
1917	31·5	39·4	42·3	3·75	Do.
1918	24·9	31·1	34·0	3·66	Area reduced
1919	29·7	37·1	40·0	3·54	Post-war conditions. Excessive cultivation again
1920	34·5	43·1	45·5	3·40	Estimated

Cotton Areas

In addition to the uncontrolled method of collection of the annual returns of areas, it was ascertained later that the feddan itself varied considerably in dimensions in different districts, and the common method employed by the native official for calculating the size of an irregular piece of land was mathematically incorrect.

Previous to 1894 there were no official records of areas under cotton, and only in the year 1887 was an attempt

made to obtain such figures by one, Boinet Bey. The actual value of these for statistical purposes is, however, small, as there was no organisation to be depended on to make an accurate computation.

In 1894 a system was instituted for obtaining returns at one period of the year by means of information furnished through the village "sarraf," or tax-collector in each village. This system has been employed ever since, and although, during the last fifteen years, periodical checks of certain villages have been carried out by the Survey Department, no attempts at verification of such returns seem to have been made previous to 1905. In the writer's contribution to the British section of the International Association for Tropical Agriculture, entitled, "The Cotton Worm in Egypt" (this BULLETIN, 1912, **10**, 584), it is mentioned that the records, at any rate until the year 1900, are open to considerable doubt in respect to their accuracy.

Increased Water Supply

There is no doubt that, owing chiefly to the better drainage conditions which prevailed up to the year 1900, the preceding years were the most favourable for cotton cultivation in the Delta, during which period the Barrage could only hold up to 14 metres on its gauge. Sir William Willcocks (*Bull. de l'Instit. Egyptien*, 1911, p. 197) remarks that up to this time the spring level was not generally too high, and the existing canals were sufficiently deep to carry their summer supplies, while at the same time their banks were not strong enough to permit water being carried in them at an injuriously high level. These canals, moreover, when closed for irrigation purposes, acted as drains to the lands and kept the water-level in the soil conveniently low. It is, therefore, conceivable that in such favourable circumstances a higher yield of cotton was obtainable than was the case later when more irrigation water was present over the same areas and levels remained constantly higher. It is, however, scarcely credible that the average yield of cotton in the country reached as high as 5·8 kantars per feddan (the figure recorded for 1897), or that the mean average for the last six years of the century was 5·34 kantars.

From 1901 the Delta Barrage was enabled to hold up more water, and in 1903 the Assouan Reservoir commenced to be drawn upon, and the irrigation facilities of the country were enormously increased. Whatever benefit this extra water supply gave to the cultivator in respect to the ability to obtain more crops from his land, the effect was not a favourable one in relation to his chief crop—cotton. From 1900 to 1905 the annual average only once exceeded 5 kantars, and, for the whole period, the mean average was 4·53. If the previous six years' mean average were accurate, this would indicate that a deterioration in production of cotton per feddan was 0·81 kantars; but, even at a more moderate estimate, it may be assumed that the loss of half a kantar per feddan was occasioned by the enhanced supply of water to the land unaccompanied by adequate provision of drainage. This innovation brought about the partial asphyxiation of the root system during the fruiting period of the plant in each subsequent year, and caused flower- and boll-shedding and consequent crop loss.

From 1906 to 1913 the mean average yield per feddan fell to 4·26 kantars, due chiefly to the cumulative effect of repeated water-logging together with other factors, among which the chief were the too-frequent occurrence of cotton in the crop rotation without compensating manuring, and the advent of a new insect pest from India—the pink boll-worm.

With regard to the further depreciation in yield in the last seven years, so many new and unforeseen influences have affected the cotton crop that it is hardly possible to regard the condition as approaching a normal one. Some attempt will be made in the proper place to explain the disappointing yields of these last years, and to indicate how improvement may be established in the future. These matters, however, will be dealt with under the independent headings previously mentioned.

1. *Deterioration of the Productive Power of the Soil in Cotton-growing Areas*

(*a*) *Excessive Cotton Cultivation.*—It is an accepted maxim among Egyptian cultivators, that the correct

rotation of their crops admits cotton in cultivation once in every three years. This is equivalent to an admission that one-third of the cotton-growing area only should bear that crop each year. To express this in equivalent figures of average and taking the perennially irrigated lands as 4,513,000 feddans—the mean of a number of years—it follows that the ideal area to be planted with cotton each season should be approximately 1,500,000 feddans. In arriving at this figure it has been taken into consideration that certain permanent plantation areas are included in the basis figure, but the deduction for these is regarded as compensated by the amount of cotton grown under well-irrigation outside the perennially irrigated areas. On reference to the table it will be seen that from 1905 up to 1920 (with the exception of 1915 and 1918, when war legislation compelled the reduction of cotton cultivation in favour of that of food crops), this ideal figure had been regularly exceeded—sometimes by as much as 10 per cent. for the whole of Egypt, and by over 12 per cent. for that of the Delta or Lower Egypt taken alone. It follows, then, that in these years a large part of the cotton-growing land carried that crop upon it more than once within the rotation (three years), with the natural consequence that the soil ingredients were drawn upon in an uneven manner and the balance of fertility was upset. A great deal more, however, has been made of this matter than it deserves, for the effect of this abnormal excess of cotton in the rotation is not permanent and can be remedied by the judicious application of manure and chemical fertilisers. The fault lies in that advantage has not generally been taken to apply the remedy when the opportunity presented itself for doing so, while, within recent years, insuperable difficulties have been met with which rendered it almost impossible to obtain manure at all. One of the chief incentives to the practice of excessive cotton cultivation has been the custom of leasing land to tenants on short terms (three years). This has induced great competition among applicants, and the highest rents are paid to landowners who permit the greatest amount of cotton to be cultivated within the period of the lease. The tenant, having no interest in the land

beyond the term of his tenancy, extracts all the cotton possible during that time, but does not attempt to re-establish the fertility of the land for his successor.

This, then, is the true cause of the deterioration associated with excessive cotton cultivation. Land wherein the owner does not permit cotton to be grown on more than one-third of the area in each year does not bring in so high a rent as where one-half the area is allowed to carry the crop annually. On estates managed by their owners it is not usual to find cotton growing in excess of the normal figure; but, in recent years, direct cultivation has been largely replaced by tenancies of the kind just referred to.

In spite of the fact that excessive cultivation of cotton has rendered some areas less productive of that crop, renovation of fertility in these cases is not difficult, and could readily be established, were it not that other noxious influences were affecting the soil at the same time. The evil effects of over-cultivation of cotton are, perhaps, the least to be feared—so long, at any rate, as it remains possible to apply the requisite manure at a moderate price.

(*b*) *Rise in the Water-table in the Delta.*—As previously shown, the years in which cotton production per acre was at its highest were those in which the water-supply to the Delta was limited by the amount which could be carried by the deep canals in their turn, and in no case could an excessive height be reached on account of the small head which the Delta Barrage was capable of holding up, and the weakness of the banks of the canals themselves. Owing to these limitations, the soil drained into the canals when their flow was shut off, and, in consequence, did not become sodden. After the Assouan Reservoir commenced to be drawn upon, much more water became available for irrigation, but the canals ran at a higher level, rendering most of the area to which water had previously to be lifted by great exertion what is termed "free-flow." The free-flow areas are those in which the water-level of the canals is higher than the land itself, and by merely opening a sluice the water runs by gravity on to the land and irrigates it. The simplicity of this operation doubtless induced cultivators to apply water

more lavishly than they would have done were they still compelled to lift it from a deep canal. This facility given to the cultivation has really proved a terrible misfortune. In addition to the over-watering of the soil, the infiltration of the high-level canals was continuous, and the water-table rose throughout the season, owing to the lack of an adequate drainage system being employed to carry off the excessive water furnished by the new canalisation scheme. On examination of the contourage of the Delta it will be seen that large depressions occur in parts receding from the Nile branches and main canals, some being even below sea-level. It will easily be seen that, without proper drainage these must act as receptacles for the water from the higher lands in their vicinity, and this is what actually happens to a greater or less degree in much of the land in the middle Delta. The injurious effect on growing cotton is dual. The first is that caused by the rise of water above the root system, which had established itself deeply to obtain moisture in the early months, the rising water asphyxiating these roots and producing flower- and boll-shedding, and not infrequently premature death of the plant. The second, and, perhaps, more important result of the lack of adequate drainage is the return of noxious salts, which in the low water-table days, before the Assouan Reservoir began to operate, had been precipitated to a depth which was beyond the reach of the root system. With the rise of water in the soil, the salts were again brought in solution to near the surface, and by surface evaporation remained within the cotton-root growth area, to the detriment of the crop. The toxic effect of the return of salt can be seen in many parts of the middle Delta, even in places which formerly possessed the reputation of being first-class cotton areas.

In connection with this very important question, it is opportune to refer to a short paper by Mr. H. Hurst, contributed to the *Agricultural Journal of Egypt*, Vol. II, Part I (1912) and entitled, "Abstracts of some Papers Published in Egypt Dealing with Subsoil Water." In this paper Mr. Hurst refers to the valuable contributions by Mr. Lucas on the analyses of drainage waters of Egypt, in the following publications: *Cairo Scientific Journal*, Vol.

II, p. 413, and Vol. V, p. 190. These deal with the salt-content of some agricultural drainage waters of Egypt, and show that where a high water-table and no drainage occurred there was a concentration of injurious salts in the surface soil, causing it to become useless for cultivation.

During recent years it has been recognised that the remedy for this condition lay in the establishment of proper drainage, and it was very largely due to the indefatigable energy of the late Lord Kitchener that a comprehensive scheme was at length evolved to bring this about. Demonstrations of the effect of good drainage applied to lands suffering from impoverished fertility doubtless assisted in the general acceptance of the view that drainage was as important as water supply to the cultivator, and that the institution of the former was equally deserving of support from the National Exchequer. The European War, unfortunately, delayed the work, and but a small part of the drainage of the Delta has as yet been carried out. In those parts in which this has been done, and in which for nearly twenty years the water-table rose annually and deposited the noxious salts in the surface soil, great improvement in production must eventually ensue. It is, however, these areas which are being pointed to, by those who seem to doubt the value of contingent drainage, as examples of its unimportance. It is contended that the cotton crops from certain lands under Government supervision have but slightly improved under the new drainage conditions ; but it seems hardly fair to expect that the evil which has been wrought by the poisoning of the soil for twenty years can be dispersed in two or three by improved drainage. It must be recognised that the effect of the establishment of proper drainage will be gradual, and, in certain cases, perhaps unnoticeable for some time, owing, possibly, to the formation of a condition in the soil similar to that known as " hard-pan," for which additional expedients must be employed to restore fertility.

If the conclusion were reached that the establishment of drainage in the perennial areas was unwarranted, on the plea that insufficient improvement had resulted from the small experiments already undertaken, and, in consequence, further schemes were not proceeded with, it

would be most unfortunate and nothing could be expected in the future but the reversion of a large part of the Delta to sterility.

(*c*) *Insufficient Supply of Manures and Fertilisers, and the Introduction of Noxious Substitutes.*—In a previous section of this paper reference has been made to the need of judicious application of manures and chemical fertilisers to restore the ingredients in the soil which have been too largely drawn upon by the frequency of cotton in the rotation.

It was pointed out that manuring was a necessary sequence to the too frequent cultivation of any particular crop, and constituted the means of preventing soil deterioration. It is not of interest here to indicate the manner of application or of the nature of the fertilisers necessary in the case, but it may be said that in the whole rotation both animal manure and chemicals are required. Referring to the method by which short leases of land are held, it will be obvious that, as the tenant is not concerned with the condition of the soil after he has got as much as he can from it during his tenancy, its fertility must generally be inferior to that which it was at the commencement of his lease. The most important soil stimulant in respect to cotton cultivation may be said to be farmyard manure, of which there has been a decreasing amount annually. Cattle-breeding has been for some years an unremunerative occupation, and the diminution in the number of head of cattle in the country, during the war, especially, has been very large. The increasing tendency among the peasantry to substitute beef for vegetable food in their diet has led to the sale of calves to the butcher at an early age, and a consequent diminution of animals fed on the farm. Before the war the place of farmyard manure was being largely filled by chemicals, but the latter, though admirably suited for such crops as wheat, maize, and millet, were too rapid in their action to be useful for direct application to cotton, causing too profuse a growth of foliage and retarding the maturity of the bolls. Moreover, the facility with which nitrate of soda could be adulterated with, or even completely replaced by, common salt induced a large number of unscrupulous dealers to supply the

latter to their clients to the detriment of the soil. Large quantities of earth from ancient village sites, of different degrees of utility from a manurial standpoint, many of which even contained a predominance of noxious salts, were carried long distances to be spread upon the fields, and were substituted for the farmyard manure, of which there was an ever-increasing scarcity. During recent years the European War enhanced the difficulty of replenishing the soil; cattle became even less numerous, and chemical fertilisers were for a long time unobtainable. This state of affairs has further greatly diminished the productive power of the soil during the past six years, during which even greater calls have been made upon it than previously.

2. *Ravages of Insect Pests*

During the last ten years of the last century great alarm was caused by the seasonal attacks of cotton worm, which varied in severity. Previous to 1895 two Commissions had been appointed to devise means to deal with the outbreaks, and subsequently four other Commissions were formed for a similar purpose. The last of these Commissions, that of 1912, was wholly occupied with trials of various preventive measures, and the final reduction of outbreaks was brought about by the introduction of legislation restricting the irrigation of the clover fields after the 1st of May. By these means the final brood of insects which normally emerged from the clover fields to infest the young cotton was destroyed. But, with the reduction of the ravages of the cotton worm to a degree of insignificance, a new pest has appeared, which has exercised a far more injurious influence upon the cotton crop than did even the leaf-eating cotton worm.

In 1911 the so-called pink boll-worm was discovered in the vicinity of Alexandria, and during the next five years it spread rapidly throughout the country. The problem of dealing with this pest, which reached Egypt from India, and has since invaded nearly all the cotton-growing countries of the world, was one of very great complexity. In the first place, it rendered the production of late maturing cotton impossible, as, by reason of the multiplication of its numbers in the late autumn, no cotton bolls were left

unattacked by the insect at that time, and practically all the lint in them was rendered useless for spinning purposes. By destroying all the bolls of plants of late maturity, only seed from those plants which matured early were available for sowing in the next season. Mit Afifi, the staple brown cotton of Lower Egypt, whose fruiting period normally extended from September to December, or even January, now became useless for this very reason. Its place was fortunately taken by a new form known as Sakellarides, which, besides yielding lint of a finer and generally more attractive quality, had the tendency to ripen the major portion of its crop in the early autumn, thus enabling a good part of the cotton to be harvested before the pink boll-worm had attained the maximum of severity. The crop, however, was generally lower than that previously yielded by Mit Afifi. Owing to the peculiarities of the new pest, it was found necessary to introduce legislation for the uprooting and burning of cotton plants before the end of the year—a matter of great difficulty, because upon the cotton sticks the cultivators depended for their supply of fuel. At the same time, it became imperative that the hibernating worms within the cotton seeds should be destroyed. After numerous experiments, further legislation was introduced, compelling ginneries to treat their seed by subjecting it to hot air in machines, by means of which the resting worms were destroyed while the germinating power of the seed remained unimpaired. To add to the difficulty of the situation, the European War was being waged, and it became practically impossible to have the machines turned out in time to prevent the new pest ravaging the cotton crops throughout the country during the whole period of the war. The measures instituted to meet the ravages of this new pest are such that when fully in force a diminution of its numbers may be expected in future, and, as this result implies a retarding of the period of maximum severity, the cotton plants will have a greater opportunity of maturing their late formed bolls with less injury and so increasing their yields.

3. *Agrarian Disturbance*

Political disturbance outside Egypt has exercised, at times, unrest among the cultivators, and this has influenced

the yield of cotton per feddan to a large degree. In 1914, the outbreak of war upset the financial situation with regard to cotton so greatly that money advances to pick the crop were not forthcoming at the usual time, and cotton itself became temporarily unsaleable. In consequence of this, many cultivators left their crops unpicked, and their cotton was lost. Tenants of some farms, being quite unable to foresee how they could pay their rent owing to their inability to realise anything on their cotton, refrained from what they considered a useless proceeding, gathering the lint, which, at the best, they considered would be seized for rent. When matters were finally arranged by the Administration, a significant proportion of the year's crop was past recovery. During the succeeding years cotton areas were restricted in order to ensure a sufficiency of food supply being obtainable in the country at the critical time when the imports, upon which the country had hitherto been largely dependent, ceased. During the last seven years the mean average crop per feddan fell to 3·6 kantars, being 0·66 kantars below the mean of the preceding eight years. Immediately following the armistice, political agitation in Egypt itself resulted in disturbances throughout the country, wherein the cultivators seem to have joined in the destruction of the means of transport, among other things producing thereby the gravest injury to their own interests by placing difficulties in the way of the delivery of their cotton to the market. Much subsequent difficulty must have been caused in connection with the distribution of seed for the next season's sowing. Irrigation measures, which annually required the most careful organisation, must have been seriously affected by the disorders. Such a cumulative effect must have been produced by these disturbances that the output of cotton, as well as the industry as a whole, the latter suffering from external influences at the same time, must have received a setback which may be reflected in the events of the near future.

In this short account it is hoped that some facts have been recalled which may assist future commentators on

the depreciation of the yield of Egyptian cotton per feddan in reviewing the situation from a more general and less particular standpoint than that which seems to be usually adopted.

GENERAL ARTICLES

GIANT GRASSES FOR PAPER-MAKING

In a previous number of this Bulletin (1920, **18**, 403) an account was given of the utilisation of bamboo for paper-making. A number of other large grasses besides bamboos have been used or tested as paper-materials in various parts of the world, and many of them have been examined and reported on from time to time by the Imperial Institute. As distinguished from the bamboos, these large grasses do not belong to any one tribe or subdivision of the Order *Gramineæ*, and have no characters common to all of them, other than their tall growth and the general structural features exhibited by all grasses. Exclusive of bamboos, species belonging to some forty genera and to nine out of the eleven tribes of the Order have been tested as paper-material.

Grasses affording possibilities as paper-materials may be roughly divided into three classes: (i) the smaller, such as cereal straws and esparto; (ii) the heaviest, the bamboos; and (iii) an intermediate class of large-stemmed grasses. It is the purpose of the present article, in the main, to summarise the work that has been already done towards the utilisation of the wild grasses of this third class as material for paper-pulp, although certain smaller grasses are referred to when these occur in association with the giant kinds or might be employed in conjunction with them in paper-making.

It is difficult to suggest a collective name for the class. "Savannah-grass," though fairly descriptive of the habitat of most of the Indian representatives, can hardly be used of the giant grasses of wet river-valleys, such as many of those of Africa. "Elephant grass" has been of late mainly restricted to *Pennisetum purpureum*, at least in Uganda, although it was also applied to the true bamboo *Ochlandra*

travancorica in Southern India; whilst the Burmese "kaing," which (with various prefixes) has been shown (*Indian Forester*, 1912, **38**, 509) to be applied to at least fifteen species, has been sometimes used as if belonging only to one or two species of *Andropogon*. As has been shown by Dr. Juritz (*Union of S. Africa, Industries Bulletin* No. 7, 1919, pp. 12–13), the South African "tambuki grass," though often *Cymbopogon validus*, Stapf (= *C. Nardus*, Rendle, var. *validus*, Stapf) means nothing more than "the grass which grows in Tambuki-land or Tembuland," so that "the tambuki grass of the Transkei, the tambuki grass of Zululand, and the tambuki grass of Beira may be three or four distinct species"; whilst "dobo" is still more general, signifying merely "thick grass" or "a thicket of grass." Perhaps the term "Giant Grasses" might be adopted as a general name not used exclusively for any one species, but taken to exclude the bamboos, the well-defined members of the Tribe *Bambuseæ*. The nomenclature here adopted is mainly that of Hackel, the latest general monographer, the *Index Kewensis* and the *Flora of Tropical Africa*, a few synonyms which have been in common use having been added.

India

Baib.—It is unnecessary to say much as to *Ischaemum angustifolium*, Hackel (=*Andropogon involutus*, Steudel), the "sabai," "baib" or "bhabar" grass of Northern and Central India, which for five-and-twenty years has been the staple material of the Indian paper-mills. It grows 6–7 ft. high, and gives two abundant crops a year without irrigation. It flowers from February to June, but is generally cut in October. Repeated cutting has been found so to weaken the clumps that weed-grasses gain a predominance over it. It yields 40 or more per cent. of cellulose, and was pronounced by Routledge to be "much the same as fine esparto," with less gluten, starch and silica. It is in considerable demand for twine, and the supply for paper-pulp is quite inadequate to the local demand, and, therefore, high-priced. Raitt terms it "one of the best and cleanest materials known for the production of the finest printing and medium quality writing papers. . . . Even

the nodes do not offer any serious resistance to the action of the digestion liquors. It is, consequently, easily reduced to a clean and regular pulp by the comparatively simple treatment of digestion from four to six hours with 15 to 16 per cent. of caustic soda at a temperature of 145° C." (*Indian Forest Records*, 1913, **5**, Part III). There are more than forty other species of the genus Ischaemum in the tropics, including five in tropical Africa and three in America; but these have not been tested as paper-materials.

Ulla-grass.—A considerable amount of attention has been given to the Indian ulla grasses (*Themeda gigantea*, Hackel, sub.-sp. *arundinacea* and the smaller *villosa*), formerly known as *Anthistiria*. The larger form is most abundant in the north-west of India, especially in the sal forests, growing to a height of 17 ft., and estimated to yield 3·5 tons per acre per annum, if cut on a three-years' rotation. Raitt gave its composition as over 50 per cent. cellulose, 28 per cent. pectose, etc., nearly 15 per cent. water-solubles and over 6 per cent. lignin, and the average length of its ultimate fibres as 2·87 to 2·9 mm., classing it first among Indian savannah-grasses. Hanausek reported that " with regard to length it appears to surpass all other straw or grass celluloses. It must yield an excellent pulp combining fineness, quality and strength." When tested on a commercial scale both in India and in England, it was found difficult to bleach and hardly answered expectations, although no doubt useful for admixture (*Indian Forest Records*, 1913, **5**, Part III).

Nal:—*Phragmites Karka*, Trinius (= *P. Roxburghii*, Kunth), sometimes distinguished from the taller *Arundo Donax* as " Chota nal," is generally distributed throughout India in swampy ground up to altitudes of 3,500 ft. It is the " kyuwa kaing " of Burma. It grows from 9 to 14 ft. high, its yield being estimated by Hole at 3·2 tons per acre per annum on a two-years' rotation. Raitt gives its composition as nearly 48 per cent. cellulose, 33 per cent. pectose, etc., 12 per cent. water-soluble and 7 per cent. lignin, its ultimate fibres as averaging 2 mm. in length, and its yield as 39 per cent. of unbleached pulp, and he considers it " a first class paper-making grass," only

inferior to ulla grasses. It is, however, like munj, in considerable demand for rope, basket and mat-making (*Indian Forest Records*, 1913, **5**, Part III).

Saccharum spp.—*Saccharum arundinaceum*, Retz., apparently including *S. procerum* and *S. exaltatum*, Roxburgh, the "teng" of Bengal, "paung kaing" of Burma and "sarpat" of Rajputana, is a widely distributed gregarious species, occurring throughout India up to altitudes of 4,000 ft. It takes 3 to 4 years to reach maturity, and should, therefore, be cut on a 4 to 5 years' rotation. It grows 18 to 23 ft. in height and gives a yield of 14·8 tons of dry material per acre per annum. As with other grasses of this kind, the yield is stated to be best at the flowering season, which in this case is from October to February. The yield of bleached fibre from the entire plant is stated to be 36·5 per cent., the composition of the plant being 52·9 per cent. cellulose, 9·1 per cent. lignin, 27·5 per cent. pectose, etc., and 10·5 per cent. water-soluble matter. The nodes are highly lignified. Raitt classes this among the best of the Indian savannah-grasses either for use by itself or for admixture, and its yield per acre is more than twice the amount of any other species (*Indian Forest Records*, 1913, **5**, Part III).

S. ciliare, Anderss. (including *S. Munja* and *S. Sara*, Roxburgh), the well-known "sara sarkanda" of Bengal and "sarkara" of the Punjab, to the leaf-stalks of which the name "munj" is strictly applied, is an excellent and well-known paper-material in India, where it ranges right across the north of the peninsula. It grows to a height of 17 ft., and under a three-years' rotation will give 5·6 tons of material per acre per annum. It flowers from October to February, and yields 40 per cent. of bleached fibre. Raitt gives the composition of the entire plant as 51·4 per cent. cellulose, 32·6 per cent. pectose, etc., 10·7 per cent. water-soluble matter, and 5·3 per cent. lignin. The nodes are very slightly lignified and the pulp bleaches well, resembling in character that obtained from wheat-straw. Munj has been largely used, at Lucknow especially, as a paper-material; but is so much in demand for thatch, mats and brushes that it is in general too expensive for paper. The leaves have long been

gathered after the rainy season, dried, and twisted into very durable rope (*Indian Forest Records*, 1913, **5**, Part III).

S. Narenga, Wallich, the "thetkagyi kaing" of Burma, a very similar species, occurs in the sal forests from the Sub-Himalaya to Burma, grows 18 ft. high, gives 3·5 tons per acre per annum on a three-years' rotation, and flowers from October to December. It contains 48 per cent. cellulose, 33·9 per cent. pectose, etc., 11·3 per cent. water-soluble matter, 6·8 per cent. lignin; and is classed by Raitt as of equal value with *S. ciliare*, *S. arundinaceum* and *S. spontaneum* (*Indian Forest Records*, 1913, **5**, Part III; *Ann. Rep. Board Sci. Advice*, 1915–16, p. 131).

S. spontaneum, L., the "kans" of India, "sit kaing" of Burma and "taláhib" of the Philippines, is a widely distributed and gregarious species, occupying thousands of acres in Assam and reaching altitudes of 6,000 ft. in the Himalaya. It has vigorous underground growth, and sends up culms 7 to 14 ft. high, flowering from August to December. Its yield is reckoned at 7·8 tons of air-dry material per acre, or 2·9 tons per annum on a conservative system of two-years' rotation, and it is classed by Raitt as first-class material, either alone or for admixture. Its ultimate fibre is 0·8 to 2·8 mm. in length, and it contains 45·8 per cent. cellulose, 36·2 per cent. pectose, etc., 9·4 per cent. water-soluble matter, and 8·6 per cent. lignin. It is used when young for fodder and very largely later for thatch. Though the stems are very satisfactory as pulp-material, the leafy heads do not bleach well (*Ann. Rep. Board Sci. Advice*, 1915–16, p. 131; *ibid.* 1912–13, p. 110). The species occupies flooded or moist areas and occurs also in South China and in the Caroline Islands (*Philipp. Journ. of Science*, 1906, **1**, 460; *Indian Forest Records*, 1913, **5**, Part III).

S. fuscum, Roxburgh (= *Miscanthus fuscus*, Bentham), the "tin kaing" of Burma, a smaller species, 5 to 9 ft. high, and requiring a two-years' rotation, is a native of moist ground in Assam, Bengal and Burma, and is estimated to give a yield of 2·3 tons per acre per annum; but it is classed by Raitt as somewhat inferior in strength, and only admissible in admixture with other material

(*Indian Forest Records*, 1913, **5**, Part III; *Ann. Rep. Board Sci. Advice*, 1912–13, p. 111).

Pampas-grass.—*Erianthus Ravennae*, Beauvais (= *Saccharum Ravennae*, L.) the hardy pampas-grass, Ravenna, plume, or "wool grass" of gardens, "dolsar" of the United Provinces, ranges from North-West India to Northern Italy. It grows 17 ft. in height, flowers between August and January, and is estimated to yield over 7 tons per acre; but should be cut on a three-years' rotation. Its pulp is classed among those of the second class Indian grasses, being inferior in strength and fitted only for use in admixture (*Indian Forest Records*, 1913, **5**, Part III; *Ann. Rep. Board Sci. Advice*, 1912–13, p. 111).

Lalang.—*Imperata arundinacea*, Cyrill., which apparently includes *I. cylindrica* and *I. Koenigii* of Beauvais, is only too well known, whether as "lalang," "alang-alang," or "illuk" in India, "trank" or "Tonquin esparto" in Indo-China, "blady-grass" in North Queensland, or under other names, as a pestilent weed in the tropical and sub-tropical parts of the Old World, being one of the first plants to occupy newly opened land and the most difficult to eradicate. It reaches altitudes of 7,000 ft., has a creeping rhizome with erect, solid culms, 1 to 3 ft. high, and leaves even longer, and is represented in the warmer parts of the Himalaya by a variety *latifolia*, 3 to 4 ft. high, with broader leaves. Under a two-years' rotation it could yield 1·7 tons of dry grass per acre per annum.

On account of its abundance it has been suggested from time to time that lalang might be used for paper-making, but hitherto it has not been employed on any large scale. It is used at the present time, in conjunction with bamboo and other materials, in paper-mills in Indo-China and on a small scale in Queensland. The results of trials at the Imperial Institute with the grass from the Federated Malay States indicated that it gives a good yield of long-fibred pulp (1 to 2 mm.), which has excellent felting qualities and produces a strong opaque paper which does not shrink on drying (this BULLETIN, 1918, **16**, 271). It requires slightly more drastic treatment than Algerian esparto if the pulp is to be bleached and used for the manufacture of white paper, but unbleached pulp of good quality for the

manufacture of strong wrapping-paper or cardboard can be produced from the grass by comparatively mild treatment. The results obtained with lalang grass from Papua were not quite so favourable, but this was probably due to the material being in rather poor condition (*loc. cit.*, 1919, **17**, 153).

Messrs. Dickinson reported on the grass in 1894 as "intermediate between good straw and Spanish esparto," and as being suitable for a high-class wrapping-paper, which would be stronger if half cotton (*Kew Bulletin*, 1914, 55–59; *Indian Forest Records*, 1913, **5**, Part III).

Imperata exaltata, Brongniart, the Cogon grass of the Philippines, examined by G. F. Richmond, is a grass of similar size to lalang, growing gregariously and resisting drought, and is stated to be fit for the cheaper printing papers, but poor in colour (*Philippine Journal of Science*, 1906, **1**, 457). Its ultimate fibres are from 0·46 to 1·82 mm. in length.

Spanish Reed.—*Arundo Donax*, L., the Spanish reed, ("bara nal" in India, "alokyu kaing" in Burma), widely distributed in the warmer parts of the Old World, in wet places, grows from 5 to 16 ft. in height, and nearly an inch in diameter and is estimated in India to yield over 3 tons per acre per annum on a two-years' cutting rotation. Its composition is stated by Raitt as nearly 43 per cent. cellulose, 33½ per cent. pectose, etc., 14 per cent. water-soluble matter, and over 9 per cent. lignin. Its ultimate fibres average 1·5 mm. in length. Reeds from the Transvaal examined at the Imperial Institute furnished a pale yellowish-brown pulp, which was easily bleached, and it was found that the nodes offered little resistance to treatment (this BULLETIN, 1912, **10**, 374). Though the yield is somewhat less than that of esparto the paper produced is of fairly good quality, and the plant is placed in the first class of Indian savannah-grasses by Messrs. Raitt and Hole (*Indian Forest Records*, 1913, **5**, Part III).

Andropogon intermedius, R. Brown.—This grass, now referred by Stapf to *Amphilophis*, some of its forms being *A. glabra*, others *A. intermedia*, is a widely distributed type in India up to 8,000 ft., in Northern Australia, in Tropical Africa and in the West Indies, where it includes some of

the " sour grasses." It is known as " sandhor " in the United Provinces, and is one of the " kaing " grasses of Burma. It grows to a height of 7 ft., yields about 4 tons per acre, or 2 tons on a two-years' rotation, and is classed as a second-class paper-making material (*Indian Forest Records*, 1913, **5**, Part III).

Spear-grass.—*Heteropogon contortus*, Rœm. and Schults (= *Andropogon contortus*, L.), a grass widely distributed throughout the plains of India up to altitudes of 5,000 ft. and all over Africa and other tropical and sub-tropical regions, grows 3 to 4 ft. high, and is estimated to yield a ton per acre on a two-years' rotation. It is a good fodder grass when young, though the sharp spikelets when mature are dangerous to cattle. When tested by Raitt it proved too refractory, even after prolonged and drastic treatment, to be admissible as a pulp-material even in admixture with other grasses (*Indian Forest Records*, 1913, **5**, Part III).

Moya-grass.—*Pennisetum Alopecuros*, Steudel, is a coarse perennial grass, plentiful near water in Rajputana and on the black soil of Central India. On Mount Abu its leaves are collected for rope-making. From 15,000 to 20,000 tons are stated to be available annually in the neighbourhood of the Pench Valley coal-field in the Central Provinces; and it is said to yield 39 per cent. of easily bleachable pulp.

Dáb.—*Eragrostis cynosuroides*, Rœm. and Schults, grows on barren sand throughout Northern India, and is employed in the manufacture of coarse rope, and for thatch. It is a perennial, growing 5 ft. in height, and is estimated by Hole to yield a ton per acre per annum on a two-years' rotation. Its ultimate fibres average only 0·94 mm. in length and its pulp proved weak and difficult to bleach, so that Raitt decided that it was only suitable for admixture with superior grass pulp in a proportion not exceeding 10 per cent. (*Indian Forest Records*, 1913, **5**, Part III).

South Africa

Tambookie Grasses.—The name " tambookie," or " tambuki," as already pointed out, is used locally for several different grasses belonging mostly to the genera

Cymbopogon and *Andropogon*. The form first tested at the Imperial Institute (this BULLETIN, 1916, **14**, 163), now known as *Cymbopogon validus*, Stapf (= *C. Nardus* Rendle, var. *validus*, Stapf = *C. marginatus*, var. *validus*, Stapf), appears to grow gregariously over large areas in South-East Africa, but apparently associated with other species. Its culms are slender, but reach a height of over 5 ft.; the ultimate fibres average 0·081 in. in length as against 0·045 in. in Algerian esparto. The yield of pulp is greater than that of the latter, but lower than that of Spanish esparto. The pulp is of good quality and readily bleachable.

The allied species, *C. marginatus*, Stapf, one of the Dobo grasses, sometimes known as tambuki, but more precisely as "umqungu," seems to be found in damp places, but is stated to cover many thousand acres in the Pirie Mountains; it is not eaten by animals, but is largely used in the neighbourhood of Kingwilliamstown as litter (*Union of S. Africa Indust. Bull.*, No. 7, 1919, pp. 13–17). The name "umqungu" seems (*op. cit.*, p. 25) to belong also to *C. excavatus*, Stapf (= *Andropogon Schœnanthus*, L., var. *versicolor*, Hackel). This latter grass is stated to cover hundreds of square miles from the Kamthlabani Range to the Lebombo Mountains, growing to an average height of 12 ft., but sometimes 22 ft., a habit so much in excess of the published descriptions of the species as to render its identification somewhat doubtful. In Basutoland it appears to be of smaller growth, and to be distinguished by the Sesuto name "paticane," from *C. marginatus*, which is known as "lebate" (Phillips, "Flora of the Leribe Plateau," *Annals S. African Museum*, 1917, **16**, 334). A sample from Pretoria examined at the Imperial Institute in 1919 (this BULLETIN, 1919, **17**, 142) was apparently either this species or *Hyparrhenia hirta* (formerly *Cymbopogon hirtus*, Stapf). This latter is generally distributed in Africa on high ground, reaching 3 to 9 ft. in height, and is known in Sesuto as "Moful a tséphè," *i.e.* grazing of the springbok. The sample examined at the Imperial Institute gave results similar to those obtained from *C. validus*. The ultimate fibres varied from 0·3 to 4·9 mm. in length, but were mostly from 2·0 to 3·0 mm.

Of two grasses sent to the Imperial Institute from Pretoria in 1917, one was identified at Kew as *Cymbopogon auctus*, Stapf, the other, very similar in general appearance, as *Andropogon Dregeanus*, Nees. Both were slender, with pith in their internodes, and nodes about 10 in. apart, the former being longer (5 to 7 ft.) and yielding more cellulose and pulp. This species is known in Sesuto as "qokoa." It was found that a pulp of superior colour was obtained by removing the flower-heads and leaves.

A. Dregeanus (= *Hyparrhenia Dregiana*, Stapf) is abundant in the Transkei between the Umtata River and Port St. Johns, where it is known as "rooi grass" or "mtwentwe," and in Natal between the Umzimkulu and Umkomanzi Rivers.

Of tambuki grasses collected by Dr. Juritz, a small kind from the neighbourhood of Port St. Johns in Pondoland was identified as *Andropogon ceresiæformis*, Nees (= *Monocymbium ceresiiforme*, Stapf), known in Sesuto as "meseletso." It is described as growing only 10 to 18 in. in height (*Union S. Africa Indust. Bull.*, No. 7, 1919, p. 25, and Phillips, *loc. cit.*).

Hyparrhenia Ruprechtii, Fourn. (= *Cymbopogon Ruprechti*, Rendle), a widely distributed grass in tropical and subtropical Africa, Madagascar and tropical America, has also been examined at the Imperial Institute as a tambookie grass (this BULLETIN, 1919, **17**, 142). Its Zulu name is "um-Tshaba." It forms dense clumps with culms reaching 10 ft. in height and with hard nodes 11 to 14 in. apart. It gives a good yield of pulp, but the ultimate fibres are somewhat short, mostly ranging from 0·8 to 2 mm. in length. There is a considerable native demand for most of these tambookie grasses for thatch.

Erianthus sorghum, Nees, known as "umtala," and *E. capensis*, Nees, known by the same name and also as "Insasela," the tallest of Natal grasses, growing to a height of 12 ft. or more, are among the "dobo" or "tambuki" grasses collected, as likely to be useful paper material, by Dr. Juritz in Tembuland and the Transkei. Such grasses are generally "interspersed among bushes and trees in the

coastal districts, whence alone they would be procurable for paper-making," and it is suggested that they might be cut by Kaffir women and children at 3*d*. per 50 lb. or 10*s*. per ton, and delivered in waggon-loads of 2 tons at Willowwale for 40*s*. per ton additional, and thence to the railway between Umtata and Port St. Johns (*Union of S. Africa Indust. Bull.*, No. 7, 1913, pp. 19–25). Stapf (*Flora of Tropical Africa*, 1917, **9**, 91) suggests *Miscanthidium capense* as a more correct name for *E. capensis*, Nees, and *M. Sorghum* for *E. Sorghum*, Nees.

Dek, or Thatching-grass.—This species, *Andropogon Buchananii*, Stapf, from South Africa, has been tested at the Imperial Institute. Its stems are slender, 4 to 5½ ft. long, with pith in the internodes and somewhat refractory nodes 10 to 15 in. apart: the ultimate fibres are mostly 1·5 to 2·5 mm. in length, and somewhat drastic treatment is requisite to bleach the pulp to a pale-cream colour; but the paper produced is opaque, of good strength and quality, and does not shrink appreciably on drying. It gives a good long-fibred pulp suitable for strong brown paper, or, after bleaching, for fairly good cream-coloured or white paper, and is regarded as of about the same value as Algerian esparto (this BULLETIN, 1918, **16**, 129).

Steek Grass.—*Trachypogon plumosus*, Nees, a polymorphic and plastic species, represented in America from Texas and Arizona to the Argentine, in Africa from the Congo southward, and in Madagascar, comprises most of the forms included under *T. polymorphus*, Hackel, under which name a sample from Rustenberg was reported on by the Imperial Institute (this BULLETIN, 1919, **17**, 143). In the length of its ultimate fibre, yield of cellulose and character of pulp it proved very similar to the tambookie grass, *Hyparrhenia Ruprechtii*, examined at the same time (see p. 183).

Rooi, or Kangaroo Grass.—Among the grasses known in South-East Africa as rooi or red grass, in addition to the "mtwentwe" (*Andropogon Dregeanus*) referred to above, is *Themeda triandra*, Forsk. (including the African forms of *T. Forskalii*, Hackel, *Anthistiria imberbis*, Retz. and *A. ciliata*, Nees). This grass occurs under somewhat varying forms throughout the tropics of the Old World.

It is one of the most useful fodder grasses in India, and a form or nearly related species (*T. australis*, Stapf), well known as kangaroo grass, is much valued for the same purpose in Australia. In South Africa it occurs over large tracts of country in Cape Colony, Tembuland, Pondoland and the midlands of Natal, being by far the commonest species of grass both in the high and low veld of South-East Africa, though much taller and coarser in the high veld. Mr. Sim considers that in Natal and the Transkei it is more abundant than tambuki; and that, as it is not there used for grazing, any quantity could be delivered at a railway station at a cost of £1 per ton (Watt, *Dict. Econ. Prod.*, i, 265; Stapf, *Flora of Tropical Africa*, 1919, **9**, 416; *Union of S. Africa Indust. Bull.*, No. 7, 1919, p. 17). In Zululand it is known as "insinda," and in Sesuto as "sebôku." A sample of one form of the species from Pretoria was found on examination at the Imperial Institute to have ultimate fibres mostly 1·5 to 2·0 mm. long, and to yield about the same quantity and quality of pulp as the tambookie and dek grasses. The nodes are, however, harder than in those species and would necessitate thorough boiling and beating (this BULLETIN, 1919, **17**, 145).

Johnson Grass.—The wild African species used as fodder grass in America under the name of Johnson grass (*Sorghum halepense*, Persoon) has been subdivided by Dr. Stapf, and one species separated from it as *S. verticilliflorum* is stated (*Flora of Tropical Africa*, 1917, **9**, 117) to range throughout eastern tropical Africa and to have been introduced into India, as "tabucki grass" and also into Australia, Polynesia and the West Indies. Johnson grass from South Africa has been examined at the Imperial Institute (this BULLETIN, 1918, **16**, 127), but was considered not very promising as a paper-making material, the large proportion of parenchyma, or "pith," causing the paper to shrink in drying and become parchment-like, whilst the pulp failed to bleach well.

Andropogon hirtiflorus, Hook. fil. var. **semiberbis**, Stapf.—This grass, now known as *Schizachyrium semiberbe*, Nees, has been examined at the Imperial Institute, the sample (from South Africa) consisting of slender stems about 3 ft. long with soft pith in the internodes, and nodes

10 to 12 in. apart. The ultimate fibre was mostly 0·6 to 0·7 mm. in length and the yield of pulp was 50 or more per cent., bleaching to a good colour, but giving a paper weaker than those of the tambookie grasses (this BULLETIN, 1918, **16**, 133). Stapf describes this grass as reaching 5 ft. in height, and as widely distributed in tropical Africa (*Flora of Trop. Africa*, 1918, **9**, 195).

Tristachya Rehmanni, Hackel.—This is a coarse tufted plant occurring in the high veld of the Transvaal, and was examined at the Imperial Institute in 1919. The culms had few nodes and gave a good yield of pulp; but the ultimate fibres were mostly only about 1·0 mm. in length, so that the paper, though opaque, was rather weak, and it was suggested that, as a material for local use, this grass might be mixed with others of better quality, such as tambuki grass (this BULLETIN, 1919, **17**, 146).

Aristida sp.—A species of *Aristida* from the Transvaal was examined at the Imperial Institute in 1912 (this BULLETIN, 1912, **10**, 375). It was stated by the authorities at Kew to be near *A. Burkei*, Stapf, a species known from its use for brooms in Basutoland as "lefièlo" and occurring on the high veld of the Orange River Colony and the Transvaal. As Raitt found *Aristida cyanantha*, Steudel, to be "quite inadmissible in mixture" with other grass pulp, and there are 26 species of *Aristida* native to the Union of South Africa, it is obviously important that the species reported on should be more precisely identified. The sample was 2½ to 4 ft. high, had ultimate fibres averaging only 0·034 in. in length, and gave a rather low yield of pulp which would probably be unfit for use except when mixed with better material. The pulp, being inferior to ordinary chemical wood-pulp, could not be remuneratively exported to Europe, but might be profitably manufactured for local use (*Union S. Africa Industr. Bull.*, No. 7, 1919, p. 66).

Panicum obscurans, Stapf.—This grass, also known as *Isachne obscurans*, Woodrow, is stated to be very common on the high veld of South Africa. It has been examined at the Imperial Institute and found only suitable for cardboard or brown paper, mainly because of the presence of numerous resistant chaffy bracts (this BULLETIN, 1919, **17**, 147).

East and Central Africa

Elephant Grass.—*Pennisetum purpureum*, Schumacher (= *P. Benthamii*, Steudel), known in Rhodesia as " zinyamunga " or " Napier's Fodder," is a tufted perennial grass with culms reaching 6, 10, or even 20 ft. in height and an inch in diameter at their bases, which abounds over a wide range between 10° N. and 20° S. in tropical Africa both West and East, along water-courses, in marshes, forest, and reed-jungles, and in a smaller form reaches altitudes of 5,000 to 6,000 ft. In the drier parts, as on the savannahs of East Africa, it seldom grows to a greater height than 6 ft. In appearance it resembles a slender bamboo, and the mature stems are very hard. It has been stated that not less than 10 per cent. of the land surface (*i.e.* 6,500,000 acres), and possibly 30 per cent., is under elephant grass in Uganda. It grows rapidly after being cut, so that there seems no reason to suppose that it will suffer from repeated cutting. It has been calculated that two crops could be cut annually, yielding a total of 60 tons of dried grass per acre, from which 25 tons of pulp could be obtained.

A sample of the dried mature grass from Uganda was sent to the Imperial Institute in 1912 for examination as a paper-material and further experiments were made in 1916. The ultimate fibres were found to average 0·08 in., *i.e.* longer than those of esparto, but shorter than those of bamboo; and the numerous nodes were not found troublesome as they were stated to have done in Togoland. Though it was considered that the grass would not obtain a higher price than average esparto, and in view of the higher cost of transport could not therefore be profitably shipped to Europe, it was thought that pulp made in Uganda would equal soda wood-pulp in value (this BULLETIN, 1913, **11**, 68). The favourable results obtained on a laboratory scale have been confirmed by a large-scale trial conducted at a paper-mill in the United Kingdom, and the material has since been used for Government printing paper in Uganda and appears quite satisfactory. The paper is tough, of good colour and fine surface, taking either writing or printing ink well.

Australia

Lalang Grass.—Reference has already been made in the section on India (p. 179) to the use of lalang grass, or blady grass, as it is known in North Queensland, for paper-making, but further mention of it may be made in this place on account of its being employed for pulping on a small scale at Cairns, Queensland (*Bulletin*, No. 11, 1919, *Commonwealth Advisory Council of Science and Industry*). It is considered unlikely, however, that its utilisation in Australia for paper-making will be profitable.

Porcupine Grass.—Known generally as "spinifex," *Triodia irritans*, R. Brown, covers large areas of the deserts of the interior of Australia, often to the exclusion of all other vegetation. Its rigid involute leaves have been suggested for paper-making, but tests made with material from Western Australia by the Australian Paper Mills Co., Ltd., Melbourne, indicated that it would not be suitable for the purpose (*Bulletin*, No. 11, 1919, *Commonwealth Advisory Council of Sci. and Indust.*).

Prairie Grass.—*Spartina cynosuroides*, Roth (= S. *Schreberi*, J. F. Gmelin), belonging to the *Chlorideæ*, is not a large grass, but has been recommended for cultivation as a paper-material in Victoria. It is a native of freshwater swamps in eastern North America, is a perennial and is said to be equal to esparto in value (*Spon's Encyclopædia*, 1882, p. 997).

West Indies

Pará Grass.—The well-known South American fodder-grass, *Panicum molle*, Schwartz (= *P. barbinode*, Trinius), cultivated under the name of Pará grass in Florida, Texas and the West Indies, has been employed in Trinidad in conjunction with bagasse and bamboo. Prof. Carmody estimated in 1910 that 30,000 tons of bagasse-pulp, worth £12 per ton, available annually in Trinidad, would be increased in value to £15 per ton by the admixture of bamboo and Pará grass (this BULLETIN, 1910, **8**, 150).

Camelote, *Panicum myuros*.—This grass, covering large areas in Venezuela, and occurring also in Trinidad, was suggested at the Venezuelan Exhibition of 1883 as a paper-

material; but, though strong, its pulp is only suitable for wrapping-paper (Dodge, *Fibre Plants of the World*, p. 257).

Uniola racemiflora, Trinius (= *U. virgata*, Grisebach).—This West Indian grass has been stated to be useful for paper-pulp, although inferior to esparto (S. C. Phillips, *Journ. Soc. Arts*, 1915, **63**, 615).

General Conclusions

On reviewing the evidence here summarised it does not seem to have been ascertained—except, perhaps, in the case of the Indian savannah grasses—how far these wild giant grasses could withstand repeated cropping, or on what rotation this would be possible. Though many of them are gregarious, and cover considerable areas almost to the exclusion of other species, careful local surveys would be necessary to determine the existence of adequate accessible supplies to meet the demands of a mill, which must in any case be near ample supplies of fresh water and possess transport facilities by water or rail. In the case of most grass pulps it would appear that the material is more fitted for an auxiliary supply, or for mixing with other pulps, than as a substantive material to be manufactured into paper by itself. In some cases, as that of elephant grass in Uganda, grasses might satisfy a local demand, and leave a margin for the manufacture of pulp for export; in every case it is necessary that the grass should be converted into half-stuff in the country of origin, as, under present conditions, the raw material would not realise a sufficiently high price in Europe to allow of the cost of transport.

INSECT PESTS IN THE COCOA STORE

At the Fifth International Exhibition of Rubber, Other Tropical Products and Allied Industries, held at the Royal Agricultural Hall, London, June 3 to 17, 1921, Mr. A. W. Knapp, B.Sc., F.I.C., of Messrs. Cadbury Bros., Ltd., read a paper on Insect Pests in the Cocoa Store. Mr. Knapp has kindly furnished a copy of his paper to the Imperial Institute, and, in view of the fact that the subject has received comparatively little attention in published litera-

ture on cocoa, it has been thought desirable to print the paper in this BULLETIN, and it is therefore reproduced below in a slightly abbreviated form.

MEANS OF INFECTION

The number of possible ways in which cocoa beans can become infected with insect life is considerable.

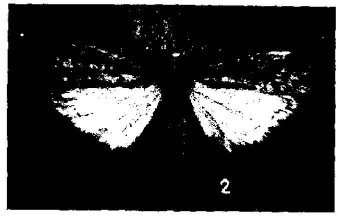
(*a*) *By Insects on Trees and Pods.*—None of the insect pests occurring on the trees and pods has hitherto been regarded as troublesome in stored cocoa. A beetle (*Aræocerus fasciculatus*), however, which is found on dead cocoa pods, and which there actually serves a useful purpose by feeding on the mould, has been found by Mr. Knapp feeding on West African cocoa beans. Mr. W. H. Johnson has observed the closely related beetle *Aræocerus coffeæ* to be destructive of stored cocoa on the Gold Coast.

(*b*) *On the Drying Platforms and in Tropical Stores.*—Small moths of the Pyralid type have been observed and identified in the cocoa stores in such widely separated places as Ceylon, Java and the Gold Coast. Mr. Knapp has seen them in Trinidad hovering round the drying platforms, and flying in the cocoa store.

(*c*) *In Transit.*—In the holds of the ocean liner, the cocoa may be placed alongside other cargo which is attacked by insect pests. The cocoa runs further risk of contamination in the same way in the stores in Europe.

As a rule, cocoa which is badly infected is easily recognised by breaking the beans, which contain the powdery excreta and silky threads of the caterpillar, or by observing caterpillars actually crawling on the outside of the bags, or by finding them spun up in cocoons in the ears of the bags. Recent infection, however, is not always evident. The moth may have laid eggs on the beans or the bags, and, as the eggs are much smaller than a pin's head, the cocoa will appear perfectly good. If, later, this cocoa is stored under conditions favourable to the development of insect life, the grubs will hatch out and proceed to consume the cocoa. These grubs possess fairly sharp jaws, and have often been observed to eat their way through paper and thin tinfoil. It is doubtful, however, if they ever eat their way through the shell or husk of the cocoa bean as long

PLATE I



3

4

5

6

FIGS. 1, 2.—The Mediterranean Flour Moth (*Ephestia Kühniella*).

FIG. 1.—As the moth usually appears from above (natural length, 10 mms.). Note the palpi projecting from front of head.

FIG. 2.—The moth with wings stretched out to show markings (natural wing expanse, 20 mms.).

FIGS. 3-6.—Beetles.

FIG. 3.—*Ptinus tectus* (natural length, 3 mms.).
FIG. 4.—*P. fur* (natural length, 4 mms.).
FIG. 5.—*Aræocerus fasciculatus* (natural length, 4½ mms.).
FIG. 6.—*Necrobia rufipes* (natural length, 5 mms.).

as they can obtain food in any other way. Hence, broken, cracked or germinated beans are more liable to be attacked.

It will be realised, from the above, that practically all cocoa is liable to be infected with insect life when it is received in the stores in Europe.

VARIETIES OF INSECTS

(*a*) *Moths.*—The most frequently found pests are small silvery Pyralid moths belonging to the genus *Ephestia*. At first sight they closely resemble the nearly related clothes moth.

The best known species of *Ephestia* is the Mediterranean flour moth (*Ephestia Kühniella*), the larvæ of which often occur as a pest in mills and granaries. It was the caterpillar of this moth which worked great destruction in our soldiers' biscuits during the Boer War. As far as Mr. Knapp's observations go, this is the species most frequently found on cocoa. However, the two species which have up to now been commonly recognised as the cocoa moth are *Ephestia cautella* Wlk., and *Ephestia elutella*. The former is well known as a cocoa pest in Ceylon, and it is also stated to occur in stored cocoa in the Gold Coast. *Ephestia elutella* is mentioned by C. J. J. van Hall as being a cocoa-store pest in Java (*Cocoa*, London, 1914, p. 239). Mr. Knapp has found it in an English cocoa store.

Besides the species above mentioned, Lechmere Guppy has identified the moth in a Trinidad cocoa store as *Ephestia figulilella*, Gregs. Judging from a specimen Mr. Guppy sent to Mr. Knapp, this appears to be very near to *Ephestia elutella*, which is stated to be liable to some variation.

All the moths are similar in size, being from ⅝ to 1 in. across when the wings are expanded. Their general appearance is also very similar, the colour varying from slate-grey to brownish-grey. The wings and body are covered with thick scales. They all fly chiefly at night-time.

The eggs, which are very small, are ovate and pale-yellow in colour. They are generally laid singly (the exception to this is *Ephestia figulilella*, which Lechmere Guppy describes as laying eggs in irregular clusters on or between cocoa beans). The female may deposit eggs at any season of the year, each individual depositing about 250 eggs in all.

It has been stated by Zipperer (*Manufacture of Chocolate*, 1902, p. 99) and Whymper (*Cocoa and Chocolate*, 1921, p. 131) that the moth lays its eggs inside the outer shell of the bean. This is not generally possible, and the error may have arisen from the fact that the caterpillar, when first hatched out, is very minute and searches for a crack in the shell of the bean. Having got down a crack into the bean, it then feeds (not only on the seed skin, as is sometimes stated, but on the cotyledons themselves), and grows, so that when the bean is opened the caterpillar appears too large to have got in from the outside.

The caterpillars average about $\frac{3}{8}$ of an inch in length, and vary in colour from almost white to pale reddish-yellow. They are semi-translucent, so that the colour of their food-stuff affects their appearance. The head is resin-coloured and bright. They have only a few hairs. A characteristic feature of all of them is the two parallel lines of dots down the back. They all spin a considerable amount of silky webbing. Mr. Hartley Durrant says that *Ephestia elutella* will cover a sheet of glass entirely with a silken web. Mr. Knapp has seen large tin lids and even whole bags of cocoa covered with webbing by this species.

The time taken for the eggs to hatch out is from one to two weeks. The caterpillar stage appears to be rather a lengthy one, varying from eight to eighteen weeks; the caterpillar then becomes a chrysalis, and in about two weeks the moth emerges.

In stores in England, moths are sometimes seen all the year round, but are most numerous in June and July. During the summer months they lay eggs; a few caterpillars are observed in August and September and increased numbers in October.

In tropical countries, and in warm places, the whole life cycle takes little more than two months; but in cool stores in England the cycle generally takes a year.

(*b*) *Beetles*.—Whilst the caterpillars of the moth *Ephestia* are by far the commonest and most evident in the cocoa store, beetles are frequently present. Accra cocoa purchased in Liverpool has recently been far more infected with beetles than with caterpillars of the moth *Ephestia*. Mr. Knapp considers that the stores in Liverpool

must be partly to blame for this, because cocoa obtained direct from the Gold Coast is almost free from beetles.

In 1917 Mr. Knapp observed a small dull grey-brown beetle about one-fifth of an inch long on some West African cocoa. This beetle was identified as *Aræocerus fasciculatus* by the authorities at the British Museum, who stated that it is not British, and, when found in England must have been imported from the tropics. As mentioned above, this beetle is found on dead cocoa pods, and it—or allied species—may become a serious pest to cocoa stored on the Gold Coast if care is not taken. The larvæ attack cocoa. They make a smaller hole in the bean than the caterpillar of the cocoa moth, and they produce finer and less abundant excreta, which, unlike the excreta of *Ephestia*, is not held together by silken threads. The beetles fly easily and frequently, and thus may rapidly spread from one stack of cocoa to another. They only appear to thrive at tropical temperatures, and probably need not be feared as a store pest in England.

Ptinus tectus, a tiny beetle about one-tenth of an inch long and dull brown in colour, ranks next to *Ephestia* in importance as a pest. The grub is small, white and partially curled up. Mr. Knapp has found them in cocoa from the Gold Coast, Para and Surinam.

Ptinus fur is a small beetle somewhat longer than *Ptinus tectus*. Its most notable characteristics are the short fur on its back and the white spots on its wing cases. Mr. Knapp has found this beetle on bags of cocoa from the Gold Coast, Para and Grenada. They are not so frequently found as *Ptinus tectus*, and apparently do little damage.

A small beetle having a bright blue body and red legs, identified by the British Museum as *Necrobia rufipes*, the "ham beetle," has also been noted in a cocoa store. As this beetle only feeds on animal products, it must be assumed that it lives on the caterpillars of other insects which are present on the cocoa beans.

Loss of Cocoa

The producer of cocoa will naturally wish to send out his product as free from insect life as possible, because the buyer pays less for "grubby" cocoa. That the beans

are infected, however, is not always evident when they reach Europe, and further damage may occur during their storage in temperate climates.

Anyone who has observed a bag of cocoa beans (which was apparently free from insect life) after some months in a store become attacked by caterpillars, which later crawl out of the bag, will realise that these caterpillars have fed on the cocoa in the bag, and therefore beans have been spoiled and cocoa has been lost.

If the individual beans are examined they are found to contain holes often filled with a brown dust which is the caterpillar's excreta. As the caterpillar's excreta will be weighed with the cocoa, it is possible that very little loss would be noticed in the weight of the bags of "grubby" cocoa. The cocoa, however, has been spoiled, and if a manufacturer uses this cocoa he must very carefully clean it, which entails a considerable loss.

One caterpillar may nibble several beans but nearly always is content with one, and to grow 100 caterpillars from birth to maturity requires as much material as there is in ten cocoa beans (*i.e.* about 11 grams, or two-fifths of an ounce). In a bag of cocoa containing 1 per cent. of "grubby" beans, the caterpillars will have eaten up to three ounces.

The percentage of "grubby" beans varies very much, but in recent years has—in the main bulk of the world's cocoa—seldom fallen below 1 per cent.; the average for the world's production is from 1 to 2 per cent. The following table gives the mean of samples taken at intervals from 1916 to 1920:

Kind of cocoa.	Insect-attacked beans. *Per cent.*
Grenada	0·5
Bahia	0·5
Trinidad	1·0
Samoa	1·0
Jamaica	1·0
Arriba	1·0
Para	1·0
San Thomé	1·0
Carupano	1·5
Surinam	2·0
Machala	2·0
Ceylon	2·0
Accra, Grade 1	2·0
" " 2	2·5
Cameroons	3·0
Accra, Grade 3	4·0
Mean	1·6

Of the Accra cocoas, grade 1 resembled good ; grade 2, fair fermented ; grade 3, fair average quality.

Control of Insect Pests

The following remarks are concerned mainly with the Mediterranean flour moth and other species of *Ephestia* which infest cocoa, but in part are of general application.

Preventive Methods

(*a*) *Cocoa Production.*—The principal way in which the planter can help in preventing his cocoa from becoming "grubby" is by avoiding the production of cracked, broken or germinated beans, or beans of which the shell is very fragile and brittle. It will be noted that, although Ceylon cocoa is of fine quality, it is frequently found to be slightly "grubby"; this probably arises from the fact that this cocoa is washed, and hence the shell is thin and brittle. The shell becomes broken in handling, and broken beans offer a much more readily available food-stuff to the caterpillars, which under ordinary conditions do not nibble through the shell.

It might be thought that claying the cocoa would be an advantage from the point of view of preventing attack by insects. It may assist, but it is unnecessary, as can be seen by noting that Grenada cocoa (unclayed) is remarkably free from insect life, and actually better in this respect than Trinidad cocoa (clayed).

Experiment has shown that the thick coating of earth as used in Venezuela does discourage the caterpillars from attacking whole beans, but is no protection if, as is usual, a number of the beans are broken. There is no evidence that clayed cocoa, as bought, is more free from insects than unclayed. For example, in a sample of earthed Venezuela cocoa 10 per cent. of the beans were attacked by insects, whilst in a sample of Venezuela cocoa not earthed, purchased at the same time, only 1 per cent. was attacked.

Another way in which the planter can help is by bagging his cured cocoa as soon as produced, and not leaving it on the drying platform or elsewhere in uncovered heaps. He should also get rid of any broken beans or cocoa rubbish, as this provides a suitable breeding ground for insects.

(*b*) *The Store.*—The floor, walls and roof should be as smooth and free from crevices as possible. The floor may with advantage be concrete ; the walls lime-washed, and the roof flat.

As far as freedom from insect life is concerned, there is no better way of keeping the store in good condition than by providing ample ventilation. The store should preferably have a large opening at each end so that, in whatever direction the wind may be, there is sure to be a through draught. The cocoa moth thrives best in stagnant air, and objects strongly to a cold draught. Probably the best method of achieving this is to replace the ordinary doors by doors made of metal gauze, as then even at night-time, when the stores are shut, they remain well ventilated.

It is usual in some stores to place the bags on boards in order to get ground ventilation. This is good, provided the boards are kept clean, but they may become a breeding-ground for caterpillars. In place of boards, triangular rods of hard polished wood might be preferable.

The keeping of the store clean, the lime-washing of the walls at frequent intervals and the immediate removal of infected material are obvious precautions. The more rapidly the cocoa is in and out of the store the better, as movement is an aid to prevention. The store should be kept as cool as possible.

Destruction of Moths and Caterpillars

Adhesives.—In order to prevent the caterpillars passing from one stack of cocoa to another, it is the practice in some stores to place on the floor pieces of cardboard which have been smeared with a sticky material like birdlime. The object is to prevent larvæ from passing from infected stacks of beans over the floor of the store to uninfected stacks. Boiled linseed oil preparations are best. The preparation sold under the name of " Bandite " is very good, and almost any of the materials used for grease-banding of trees could be used. The months when these boards are most useful in England are August and September. Besides larvæ, some beetles are caught in this way.

The *Gordian* states that the most effective method of destroying the moth, *Ephestia elutella*, is by placing sticky paper near an electric light. Such moths as Mr. Knapp has observed in the cocoa store are exceptional in that they are not attracted by a bright light. He tried large glass globes illuminated inside by electric light, and smeared externally with adhesive, but did not catch any moths.

Pans of Liquids.—Large shallow pans of water placed near a lamp have been recommended. There is no doubt about the attraction of a pan of liquid. The liquid should be changed occasionally, as the dust which collects on the surface of the water allows the moth to escape. There is one liquid that exerts an extraordinary attraction and is more effective than any other when used in this way. This liquid is tea, prepared as for drinking with milk and sugar. Strangely enough, even cocoa prepared for drinking is not so attractive to the moth as tea.

Carbon Disulphide.—W. H. Johnson gives a method of destroying the caterpillars by pouring a small quantity (one-fifth of a drachm) of carbon disulphide upon cotton-wool and placing this in each sack, which is then tightly closed. He states that this method has no injurious effects on the cocoa. Mr. Knapp found this method moderately effective for *Ephestia*, but the beetle *Aræocerus fasciculatus* does not appear to be seriously inconvenienced. Further, as W. H. Johnson points out, the eggs of the insects are not destroyed. The use of carbon disulphide is objectionable on account of its extreme inflammability and very unpleasant odour. It is very frequently recommended for fumigation, and these objections become prohibitions when the store to be fumigated is a large one. Thus, a store of 100,000 cubic feet capacity, say 100 feet long, 50 feet broad and 20 feet high, would require about 1 cwt. of carbon disulphide. This quantity evaporated would give a bad odour to a whole village, and if a red-hot spark were accidentally produced in or near the store a very dangerous explosion might occur. Mr. Knapp tried an experiment on 200 bags of cocoa in a room of 2,000 cubic feet. He used 6 lb. of carbon disulphide (*i.e.* three times the amount usually recommended), but only 50 per cent. of the caterpillars were killed.

Hydrocyanic Acid.—This powerful poison is probably very useful for application on a small scale, but is too poisonous to produce in quantity in large stores, especially if they are in populous areas.

Carbon Tetrachloride and Trichlorethylene.—As neither of these are inflammable they would be preferable to carbon disulphide. They are about half as toxic, so that 2 lb. per 1,000 cubic feet are required.

Sulphur Dioxide.—This was found in the laboratory to be effective in killing caterpillars. It has the disadvantage that it produces sulphurous and sulphuric acids which would corrode any metal present in the store.

Formaldehyde.—Of the various chemical insecticides, this would be the least harmful in some respects, as it is neither inflammable nor poisonous. Into a room 7,000 cubic feet in capacity containing 400 bags of "grubby" cocoa Mr. Knapp volatilised six pints of formalin. The room was kept closed for twenty-four hours, and even two days after opening the odour of formaldehyde was distinctly perceived. The treatment was not a success: a large percentage of the insects were still alive, and the flavour of the cocoa was slightly spoiled.

Whymper states that spraying the sacks with formalin is very efficacious. In those cases where the insects are on the outside of the sacks this would kill them. However, it would possibly have a detrimental effect on the cocoa, as formaldehyde renders proteins indigestible.

Proprietary Insecticides.—Two or three of these have been tried, but they showed no improvement over the well-known chemical substances given above. The best had a formalin basis.

The odour of an insecticide must be carefully considered before it is used on a delicate article like cocoa beans, the odour and flavour of which are so important. Whatever is employed, both for this and other reasons, not the slightest trace of insecticide must be left in the beans after treatment.

It will be seen from the above that none of the chemical treatments proved entirely satisfactory.

Vacuum.—It is stated that on the German State Railways the whole carriage is run into an iron cylinder

from which the air is pumped whilst its contents are warmed with steam-pipes. Any insects that may be present die owing to the rapid evaporation of their body fluids. This method might be applied to truck loads of "grubby" cocoa. The treatment would have to be very thoroughly carried out, as Mr. Knapp found that the caterpillar of *Ephestia,* when exposed to vacuum in the cold, is only temporarily inconvenienced.

Cold.—The windows of the store-room can with advantage be left open day and night in winter, as at low temperatures fewer eggs will hatch out. Whilst cold retards development, it is not possible by its application to destroy the caterpillars or eggs. Both Lechmere Guppy and N. P. Booth have shown that caterpillars, which were frozen hard until they clinked like a piece of glass, were not dead. On thawing, they crawled about as before.

Heat.—The application of heat is, in Mr. Knapp's opinion, the most effective method of destroying eggs, moths and caterpillars. In some experiments in the laboratory on the caterpillars of *Ephestia* it was found that they all died on exposure to the comparatively low temperature of 120° F. (49° C.) for twenty minutes.

It is a fairly easy matter to raise the air of the store to this temperature. Where steam is available, steam-pipes could be run round the walls, and then if at any time one wished to sterilise the store, the doors and windows would be closed and the steam turned on. Another and possibly more convenient method of heating is by the use of Stanlock heaters. These consist of a coil of steam-heated pipes through which air is blown by an electric fan. All the outlets from the store having been very carefully closed, the same air passes again and again over the heated pipes until it reaches the desired temperature. Where steam is not available the hot gases produced from a coke fire may be passed direct into the store.

Provided the temperature of 160° F. (71° C.) is not exceeded, the cocoa in the store is not detrimentally affected; there is merely a reduction in moisture of about 1 per cent. Whilst it is not difficult to heat the air in a store, it is a much more lengthy operation to get the heat to permeate a heap of bags of cocoa. Thus, a room

containing 370 bags was maintained at 124–140° F. for twenty hours; at the end of that time the beans inside the bags had only risen to 110° F. If, therefore, a store containing large stacks of cocoa is to be successfully treated, it will probably require two or three days' continuous heating. If the process is properly carried out every moth and caterpillar will be killed. The eggs also are rendered sterile. Hartley Durrant (in the Preliminary Report of the Army Biscuit Enquiry) has shown that twelve minutes at 156° F. (69° C.) destroys the eggs of *Ephestia Kühniella*, and probably longer periods at lower temperatures would be equally effective.

THE UTILISATION OF DUMP COAL IN SOUTH AFRICA

THE annual output of coal in the Transvaal amounts to upwards of 6,000,000 tons. The coal is usually of a brittle nature, so that a large amount of small coal, estimated at from 800,000 to 1,000,000 tons per annum, is produced in its mining and handling. All the small coal dumped as refuse is colloquially known as *dump coal*. In some collieries the coal is classified into large or lump coal, nuts, peas, and duff, all of which is utilised with the exception of a portion of the duff, which is discarded as waste; in other collieries only two classes of coal are sold, viz. lump and nuts, all coal of smaller size than nuts being dumped as waste. Hence, although dump coal consists very largely of "duff" (dross, slack or fine), it may contain a certain amount of pea-coal and even some nut-coal.

A large proportion of the "duff" coal is utilised on the Rand, but about 25 per cent. is discarded on the dumps as waste. The accumulation of waste coal on the dumps in the Transvaal must now amount to several million tons, and, during the war, the question of the utilisation of this dump coal was investigated by the Imperial Institute. In the report furnished by the Institute to the Government of the Union of South Africa in January 1918, it was indicated that the three principal means by which this waste material may be utilised are:

(1) Direct burning for the production of electric power;

(2) Briquetting;

(3) Carbonisation for the production of coke, in which process ammonium sulphate, benzol, tar, and gas would be obtained as by-products.

These suggestions were considered by a Committee appointed by the Advisory Board of Industry and Science in South Africa to investigate the possibilities of utilising the waste coal, and the report of this Committee was published in *The South African Journal of Industries* (1920, **3**, 151). The views of the Committee on the three methods are referred to below.

A further possible method for utilising the waste coal is that of pulverisation of the coal for use as fuel for locomotives, etc.

The following account summarises the various proposals which have been made as to suitable uses for the coal at present wasted.

(1) *Direct Burning for the Production of Electrical Power*

A considerable amount of duff or fine coal is already used for this purpose in the Transvaal. In 1916, for example, upwards of half a million tons were burnt at power stations on the Rand, the Victoria Falls and Transvaal Power Co. Ltd. being the principal consumers and accounting for 400,000 tons. The South African Committee consider that it is possible that further developments in this direction will help to decrease materially the amount of small coal now thrown on the dump and regarded as waste, but that this will depend on a greatly increased demand for cheap electrical power.

(2) *Briquetting the Coal*

If the dump coal could be successfully briquetted it would be possible to utilise it for most of the purposes for which the lump coal is now employed. It is understood, however, that hitherto the question of a suitable "binder" for briquetting purposes has been an obstacle to any development in this direction in South Africa, and there is also some doubt as to whether the briquettes

could be produced at a price to compete with the lump coal, which realises a low price, on the average about 5*s.* to 5*s.* 6*d.* per ton at the pit's mouth. The cheapness of lump coal in the Transvaal must have an important bearing on the question of the profitable utilisation of the waste. The South African Committee state that about 6 per cent. of pitch would be required as a binder in making briquettes with Transvaal fine coal, and that, if imported pitch had to be used, the cost of the briquettes would be prohibitive in view of the low cost of coal in South Africa.

The difficulty of a suitable binder might, however, be overcome. Methods of briquetting coal without a binder have been introduced recently and have been stated to give satisfactory results. Briquettes thus made are stated to be equal in fuel value to the coal from which the waste is derived, and to be compact and to withstand long exposure. A large scale trial would be necessary in order to determine definitely whether any such process could be successfully adopted in South Africa as a means of employing the waste.

(3) *Carbonisation of the Coal*

This process involves the distillation of the coal for the production of coke and certain by-products, viz. gas, ammonia, benzol and tar. The possibility of successfully treating the dump coal by this method will depend on the character and value of the coke obtained and the yield of the by-products, as well as on the demand for the latter in South Africa. It seems probable that coke of satisfactory character could be made from certain kinds of the dump coal, especially if it were briquetted or compressed before treatment, and that there would be markets in South Africa for sulphate of ammonia for manurial purposes and also for the benzol and tar. The possibilities of this method of utilising the dump coal therefore deserve to be carefully considered, especially in relation to low temperature carbonisation.

A number of different processes are now available for the carbonisation of coal, and practical trials would be necessary in order to determine the most suitable method

for adoption in South Africa for the treatment of dump coal. Experiments on the carbonisation of dump coal from the Transvaal which were carried out in this country some years ago at the instance of the Middelburg Steam Coal and Coke Co. indicated that the coal furnished normal yields of by-products. The coke obtained from the uncompressed coal was rather too soft, but that made from the compressed coal was of good quality. These experiments were conducted in Simon-Carves coke ovens.

The South African Committee consider that this method of utilising the waste coal offers a promising field for investigation, and it may be of interest to record the principal work now being or shortly to be carried on with South African coal in this direction.

In Natal several collieries produce coke of good quality by retorting a certain proportion of the coal mainly in beehive ovens.

Natal Ammonium, Ltd., formed in 1913, uses anthracite coal of the Vryheid district, containing about 2 per cent. of nitrogen, for the production of ammonium sulphate. For this purpose the coal is screened to nut size. A certain proportion of the gas, resulting from the process, is carried into furnaces, and burnt under water boilers to provide steam power for fans, electric light, machine-shop and mining purposes; but the bulk of the gas, after a small amount of tar has been extracted, is wasted.

The South Africa Carbide and By-products Co. was formed in the autumn of 1919 for the purpose of manufacturing calcium carbide and of extracting motor spirit, tar oil, and other by-products from the coal and shale of the Ballengeich Collieries. There is a contract for the supply of 1,000 tons per week of "fines," small coal, and "pickings" for the above purpose.

In the Transvaal the Tweefontein United Collieries have an output of 1,000,000 tons of coal per annum. On the property is an enormous tonnage of inferior coal, containing on an average about 1·5 per cent. of nitrogen. For the treatment of this coal the Lymn-Rambush process of coal distillation has been adopted for the extraction of the nitrogen contents of the coal as ammonium sulphate. As much as possible of the gas produced in this process

will be sold to the railways and other power users. The Chairman of the Company anticipates that in time a production of 1,000,000 tons per annum will be treated for by-products only (*South African Mining and Engineering Journal*, December 1919).

Estimates made by S. B. Bilbrough, in a paper read before the South African Institute of Engineers in 1916, indicate that for a plant retorting 200 tons per day a profit of upwards of 11*s*. per short ton of coal used could then have been made by the sale of the tar and its distillates, the ammonium sulphate and coke, the value of the gas not being taken into account.

(4) *Pulverisation of the Coal*

Pulverised coal has already been used in Bettingdon boilers in Johannesburg for the production of power, but it is interesting to note that coal in a pulverised condition has been used elsewhere for combustion in locomotives. Several railways in Europe have been experimenting for some years with pulverised fuel, and have been successful in burning in this way very inferior grades of coal. The tests which have been made on American railways have been most satisfactory.

The use of such fuel would simplify the construction of the locomotive, and show results with a greater heat-efficiency, as grates and fire-doors are dispensed with. It is doubtful, however, if pulverised fuel could be used with economy on the locomotives of South Africa, on account of the cheapness of coal in that country, and especially in the Transvaal, and of the high cost of pulverisation together with that of the alterations and modifications required in the structure of the locomotives.

PLATE II

FUNGOID DISEASE OF OIL PALM IN PORTUGUESE CONGO

FIG. 1.—Palm in early stage of disease.

FIG. 2. Palm in advanced stage of disease.

NOTES

Petroleum: Imperial Institute Monograph.—A volume on Petroleum in the Series of Monographs on the Mineral Resources of the Empire issued under the direction of the Mineral Resources Committee of the Imperial Institute has been published by Mr. John Murray (price 5*s*. net). The Monograph has been prepared jointly with H.M. Petroleum Department with the assistance of Prof. H. B. Cronshaw, B.A., Ph.D., A.R.S.M.

The book, of 110 pages, is divided into three chapters, in the first of which are given particulars of the characteristics, occurrences, mining, refining and uses of petroleum, with diagrams of production. The second chapter deals with the sources of supply of petroleum within the British Empire, and includes an account of the occurrences of petroleum in Burma and Assam (India); Mesopotamia; Egypt; New Brunswick, Ontario, Alberta, and the North-West Territories (Canada); and Trinidad. The third chapter is devoted to foreign countries, and includes descriptions of the oil-fields of Boryslaw-Tustanowice (Poland), Prussia, Ceprano (Italy), Prahova (Rumania), Dossor (in the Ural-Caspian region of Russia), Baku and Grosny (Georgia), Dutch Borneo, the Keotei district of Java, Persia, Mexico, the United States, Comodora Rivadavia (Argentina), Santa Elena (Ecuador), and Lobitos and Negritos (Peru).

A map of the world shows the chief petroleum-bearing localities referred to in the text, and the bibliography includes the principal publications on petroleum. The work records numerous distillation tests, and contains many statistical tables.

Pests of the Oil Palm in the Portuguese Congo.—In the article on the cultivation of the oil palm published in a recent number of this BULLETIN, reference was made to certain fungoid diseases caused by species of *Ganoderma* (1920, **18**, 237). Mr. R. Swainson-Hall, F.L.S., has kindly supplied particulars of a closely related disease which attacks the oil palm in the Portuguese Congo. He has also furnished information regarding a beetle which infests the palm in that country. The following account is compiled from his notes, whilst the accompanying illustrations are reproductions of photographs which he has taken.

Fungoid Disease.—The fungus causing the disease, which occurs in the Belgian Congo, as well as in Portuguese territory, is *Ganoderma lucidum* (*Fomes lucidus*), one of

the Polyporeæ. It appears to be closely related to *G. applanatum* of San Thomé (*loc. cit.*) and in Mr. Swainson-Hall's opinion the two fungi may possibly be forms of the same species.

The fructification appears at or near the base of the trunk and is generally about 10–20 cm. thick × 20–30 cm. wide, forming a semi-circular sconce or bracket projecting from the trunk in the horizontal plane (Plate III, Fig. 1); the underside is velvety and of an ashen-white colour, occasionally with a trace of a yellow or greenish-yellow tint. The external surface is hard, whilst the inside is softer and more closely woven. The fungus attacks the internal tissues of the trunk, causing them to become friable and to emit a musty smell. The first indication of the presence of the disease is the falling over of the older whorl of leaves (Plate II, Fig. 1). The fructification only makes its appearance after the fungus has become well established, and is the most certain evidence of the presence of the disease. The whole of the older whorl of leaves falls away from the erect or normal position, and hangs down parallel to the trunk, the centre or youngest spike being the last to fall over (Plate II, Fig. 2). The base of the trunk of the palm, when cut open longitudinally, exhibits an ashen-grey powdery mass of rotten tissue, with a very musty smell (Plate III, Fig. 2).

According to Mr. Swainson-Hall, *G. applanatum* of San Thomé does not affect the palm leaves to nearly so great an extent as *G. lucidum*, whilst Maublanc and Navel, in their account of the former disease, also state that the leaves appear to be completely healthy in the first stages of the disease (*L'Agronomie Coloniale*, 1920, **4**, 187).

Insect Pest.—The beetles which Mr. Swainson-Hall found attacking the oil palm in the Portuguese Congo belong to the genus *Oryctes*, to which the rhinoceros beetle of the coconut palm belongs. Three species have been found on the oil palm in the Congo, viz. *O. owariensis*, *O. monoceros* and *O. boas*. The following particulars relate specially to the first named.

The beetles bore through the basal parts of the leaves into the tops or growing point of the palms. They enter the heart of the still unfolded leaves, or centre spike, and work downwards. The leaves are not eaten, but only chewed, the chewed mass being rejected into the hole, which the beetles and larvæ have made. Plate IV, Fig. 1, shows larvæ and pupæ; the larvæ are feeding and boring their way in the top of the palm. Plate IV, Fig. 2, shows two beetles and one pupa in the top of the palm stem. The two beetles have just emerged from the pupæ, and

Fig 1.—Fructifications on base of palm stem.

Fig. 2.—Base of diseased stem showing disintegrated interior.

FIG. 1.—Larvæ and pupæ of beetle in palm stem.

FIG. 2.—Beetles and pupa in palm stem.

PLATE V

INSECT PEST OF OIL PALM IN PORTUGUESE CONGO

FIG. 1.—Attacked palm with young leaves dying.

FIG. 2.—Attacked palm with centre of top eaten away.

PLATE VI

INSECT PEST OF OIL PALM IN PORTUGUESE CONGO

FIG. 1.—Top of attacked palm stem with beetles *in situ*.

FIG. 2. Base of attacked palm stem.

PLATE VII

INSECT PEST OF OIL PALM IN PORTUGUESE CONGO

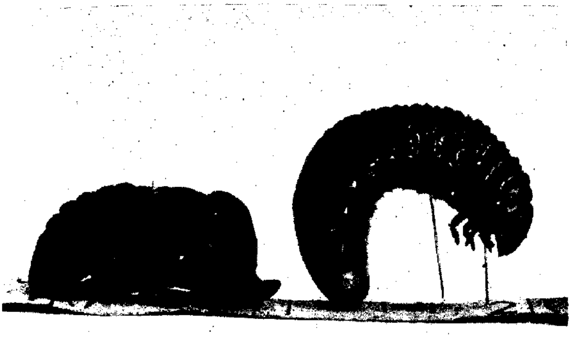


FIG. 1.—Pupa and larva of beetle.

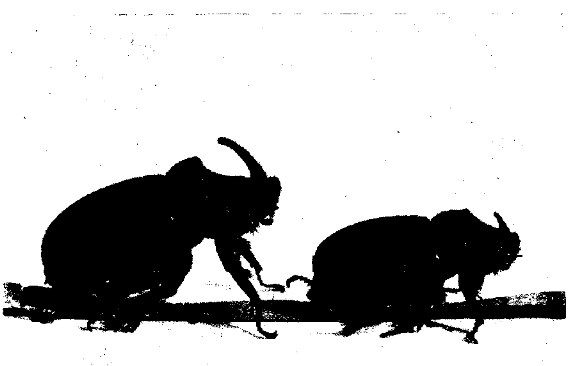


FIG. 2.—Male and female adult beetles.

(The scale in these photographs is divided into centimetres.)

have commenced boring, possibly to effect an escape from the palm ; the rejected chewed mass will be seen in the tunnels behind the beetles.

The youngest expanded leaves, usually first attacked, die off (Plate V, Fig. 1), and the leaves in the central bud generally unfold themselves, but show triangular cuts arranged symmetrically on each side of the central rib. The female beetles bore their way to the soft succulent growing point for the purpose of laying their eggs ; the resultant larvæ feed on the younger tissues and top part of the palm, which they quickly reduce to a soft, straw-like mass (Plate VI, Fig. 1). The whole of the centre of the top is usually eaten away (Plate V, Fig. 2), and, on cutting down the tree, appears as in Plate VI, Fig. 2.

The larvæ of *O. owariensis* are big white grubs, which develop into pupæ covered with a strong cocoon, the outside of which is composed of rough palm fibre, débris and excrement. The full development takes about a year, but the generations are continuous, so that all stages of development may be found together. Photographs of the larva, pupa and adult beetles are shown in Plate VII.

No remedial measures seem as yet to have been tried in the Congo, but Mr. Swainson-Hall considers that the pest may possibly be controlled through the agency of parasitic fungi, on the lines of experiments which are stated to have been successfully carried out in Samoa on infecting the larvæ of the rhinoceros beetle with the parasitic fungus, *Metarhizium anisopliæ*, (*Mitt. Naturf. Ges. in Bern*, 1918, p. xv ; *Abstract in Rev. Appl. Entom.*, 1919, **7**, *Ser. A.*, 424).

Agricultural Conditions and Needs of the Gambia.—A report prepared by Mr. M. T. Dawe after a visit to the Gambia in November–March 1920–21 has been published by the Crown Agents on behalf of the Government of the Gambia, and is the outcome of the recommendations of the Committee appointed by the Secretary of State for the Colonies to consider the staffing of Agricultural Departments, as given in their report dated May 1920.

Mr. Dawes' report forms a brochure of 52 pages ; it opens with an account of the geographical position of the Gambia Colony and Protectorate and gives particulars regarding the principal physical features, climatic conditions, area and population, and the administrative divisions of the country. Mr. Dawe visited most of the districts of the Colony and Protectorate and obtained useful information regarding the existing agricultural crops and methods,

and the natural forest products, on which to base his recommendations.

The native methods of agriculture and the implements employed are described as being of a primitive nature. The crops are grown on ridges which are thrown up, in the case of the Mandingo and Jollof cultivators, by means of a large, flat, wooden-bladed hoe, which has the handle set at an angle of about 20°, requiring the operator to bring his or her hands nearly to the ground level in preparing the ridges. The Jolahs employ a kind of hand plough for this purpose, which is worked in a more upright position. For weeding, a short-handled heart-shaped hoe of iron is employed by the Jollofs and a small draw-hoe by the Mandingos. Sickles and cutting implements are of local make and are also on primitive lines. The collection of native agricultural implements which Mr. Dawe formed has been presented to the Imperial Institute and is arranged in the Gambia Court of the Public Exhibition Galleries.

Ground nuts form the only export crop of any importance in the Gambia; the average annual export of this product, for the ten years ending 1919, amounted to 64,983 tons of the value of £634,952. Assuming the average yield to be 44 bushels per acre, this export represents an area of 118,151 acres devoted to ground-nut cultivation. In addition to the native population, the Gambia is visited by immigrant farmers from the neighbouring countries for the purpose of raising the ground-nut crop. The number of these immigrants has been estimated at 25,000, and, as they work partly for landlords as well as for themselves, they are probably responsible for raising about 50 per cent. of the ground-nut crop. During their stay in the country these farmers have to be maintained, and large quantities of rice are imported annually for their support to supplement the native food supply.

The principal grain crops grown for food are guinea corn (*Sorghum vulgare*), known locally as bassi and kinto, the former dark and the latter light-husked; millet (*Pennisetum typhoideum*), of which four varieties are in general cultivation, known to the Mandingos as suno, sannio, madjo, and Jolah sannio; rice, grown during the wet season or in swamp lands without irrigation; maize, to a small extent; and findi (*Digitaria exilis*), a small-seeded grass from which a flour is prepared. Other food crops are cassava (*Manihot utilissima*), both the sweet and bitter kinds; yams (*Dioscorea batatas*); beans or cow-peas (*Vigna catiang*); okra (*Hibiscus esculentus*); coconuts, bananas, sweet potatoes, onions, tomatoes, papaws, sugar-

cane, kola and oranges. Miscellaneous crops other than those used for food are cotton, calabashes and indigo. Cotton is grown in the interior in fairly extensive areas for local use ; there are two more or less distinct types in cultivation, one perennial, grown as a mixed crop, and the other grown pure as an annual. (For reports on samples of cotton sent from the Gambia by Mr. Dawe for examination at the Imperial Institute see p. 146.) Calabashes are grown for export to Sierra Leone and neighbouring French Possessions, whilst the indigo is employed locally for dyeing cotton cloths.

Although certain areas are covered with dense woodland there are no actual forests in the Gambia. The following trees are noted as of importance either for timber, fruit or seeds : Mahogany (*Khaya senegalensis*), common along the Gambia rivers above the mangrove limits ; rose-wood (*Pterocarpus erinaceus*) ; mampato (*Parinarium excelsum*) ; santang (*Paradaniella Oliveri*), the timber of which is employed by natives for mortars, and the resin which it yields as incense ; bantang (*Eriodendron anfractuosum*), the kapok or silk cotton tree ; tabu (*Cola cordifolia*), which yields an edible fruit ; machacharo (*Lophira alata*), which yields an oil-seed and a timber known as African oak; talao (*Detarium senegalense*), the fruit of which is sold in local markets, while the timber somewhat resembles mahogany ; rhun palm (*Borassus flabellifer*), of which the trunks are used for piles for wharves at Bathurst, and the young fruit is eaten as food ; also to be met with are *Erythrophlœum guineense*, which furnishes Sassy bark ; *Afzelia africana* ; and neto (*Parkia africana*), which furnishes a fruit known as monkey cutlass.

The principal source of Gambia rubber is *Landolphia Heudelotii* ; but it has also been collected from *Ficus Vogelii*. The export of rubber from the Gambia has now fallen to a negligible quantity. The oil palm (*Elæis guineensis*) is found in most parts of the Protectorate, but is most abundant in the Kombo and Foni Province. There is a small and increasing export of palm kernels (671 tons in 1919), but the fruits are small as compared with those of other countries, as the palms are tapped for palm wine.

Amongst fibres, the most important are piassava, obtained from the leaf sheath of *Raphia vinifera*, the wine palm ; raffia, from the leaf cuticle of *Raphia Ruffia* ; sansevieria, from the leaf of *Sansevieria senegambica* ; and baobab, from the bark of *Adansonia digitata*, this being the principal fibre employed by natives for domestic uses. Several fibres of the jute class are produced from the stems of wild and cultivated species of *Hibiscus*, *Corchorus*,

Triumfetta and *Urena*; whilst a rough fibre is prepared from the bark of *Bauhinia Thoningii*, a leguminous shrub common in the dry zone.

Although a species of mangrove (*Rhizophora racemosa*) exists in abundance, mangrove bark does not appear to be employed as a tanning material in the Gambia. A report on a sample of this bark which Mr. Dawe sent to the Imperial Institute for examination appears on page 147. For tanning the goat skins used by local leather workers, the pods of *Acacia Adansonii* are employed.

For colouring leather the natives employ Indian inks, as, apart from the crude local indigo, there appears to be a lack of dyestuffs in the country. A small quantity of beeswax, the produce of the semi-domesticated native bee (*Apis mellifica* var. *Adansonii*), is exported, after being refined by Bathurst merchants.

The native chiefs own fairly large herds of cattle, which are fed on ground-nut hay during the dry season; sheep, goats, donkeys and ponies are also kept; but there is a good deal of tsetse fly in the country, which accounts for a considerable mortality amongst the live-stock.

For the further development and improvement of agriculture in the Gambia, Mr. Dawe proposes the following measures:

1. The adoption of appropriate systems of irrigation for the cultivation of rice and other crops in the dry season.
2. Improved methods of cultivation and the use of modern implements and machinery.
3. The cultivation of additional export crops.

A proper system of irrigation, it is suggested, would permit of the extended cultivation of rice in the dry season, and this would not only ensure an adequate supply of food for the ordinary planting season, and enable the planting of rain crops to be carried on without interruption or restriction, but would result in a smaller area being required for millet, thus setting free land to be planted with ground nuts or some other export crop. It is further probable that a certain and adequate supply of food would attract a larger number of immigrants and so increase the production of ground nuts.

For improving the methods of cultivation the introduction of an improved type of hoe and animal-drawn or mechanical ploughs is suggested, as well as machinery for planting and harvesting the ground-nut crop.

The cultivation of additional export crops to supplement, but not to displace, ground nuts, is recommended. The

crops best adapted for this purpose can be ascertained only after trial cultivation, but the following are suggested by Mr. Dawe as probably suitable: tobacco, already grown to a certain extent as a native crop; maize, which has been grown experimentally, but with seed of the wrong type; rice, already grown as a native crop, but without irrigation; citrus fruits, already grown in the Kombo district, but of inferior quality, the best South African kinds of oranges being recommended to replace them; fibres for the manufacture of ground-nut bags and of ropes and cordage for local use.

At the present time there is no Agricultural Department in the Gambia, and in order to carry out the proposals made in his report Mr. Dawe recommends the formation of such a Department, with an experimental farm, and a staff comprising a Director of Agriculture, an Assistant Director, a Tobacco Planter and two Assistant Agriculturists, the latter to be trained natives from one of the West Indian Islands.

Flax Growing in Uganda.—The cultivation of flax in Uganda has hitherto been carried out only on small experimental areas. Reference to these experiments is made in the *Ann. Rep. Dept. Agric., Uganda Protectorate for the year ended* 31*st March,* 1920.

Samples of flax and flax tow grown and prepared on the Government Plantation at Kampala were forwarded to the Imperial Institute in 1920, and the results of their examination are given below.

Two bundles of flax were received consisting of fairly soft, greenish-brown fibre, which had been well retted, but had not been freed from shieve, of which a fair quantity was present.

The fibre had a length of from 19 to 27 inches in the case of one of the bundles, and from 15 to 19 inches in the other bundle. The strength was variable, but on the whole fairly good.

The tow consisted of matted masses of short fibre measuring up to about 15 inches in length. The fibre was similar in colour to the flax described above.

In the opinion of flax merchants in London, the longer fibre represented by one of the bundles of flax was of good spinning quality and would be worth about £160 per ton in London (December 1920), whilst the shorter fibre of which the other bundle consisted would only be suitable for breaking into tow and would realise about £80 to £100 per ton.

The tow was regarded as rather short and brittle, but suitable for the spinning of heavy yarns, and its value was estimated as about £60 to £70 per ton in London.

This flax was of fairly good quality, and it should be possible by better cultivation and preparation to remedy the defects of poor colour and shortness and irregularity of staple.

At the date of the Report (January 1921) the commercial value of flax had recently fallen considerably, but it was anticipated in the trade that prices would improve again later, and that, when trade became more normal, large quantities of both flax and tow of the quality represented by these samples would probably be saleable in the United Kingdom in lots of 50 to 100 tons at a time.

Samples of flax, grown by two Uganda planters, one at Busoga and the other on an estate at Fort Portal, were submitted to the Agricultural Department in 1919 and 1920 respectively. The fibre from Busoga was of fair quality in comparison with East Africa flax, but it was considered by the Agricultural Department that the crop could be improved both in quality and yield by the exercise of greater care in planting and harvesting and in the preparation of the straw and the fibre. The flax grown at Fort Portal was also regarded as of promising quality.

The Department of Agriculture is of opinion that the flax production shows promise of development in Uganda, and particularly in Toro, where it is hoped that a supply of the fibre will become available for spinning and weaving in the Church Missionary Society's school at Fort Portal.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the BULLETIN *a summary is given of the contents of the more important papers and reports received during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India and the Tropics generally. It must be understood that the Imperial Institute accepts no responsibility for the opinions expressed in the papers and reports summarised.*

AGRICULTURE

FOODSTUFFS AND FODDERS

Sweet Potatoes.—The production and uses of this crop are dealt with in an article entitled "The Sweet Potato and its Cultivation along the Southern Coast Belt," contained in *Journ. Dept. Agric., Union South Africa* (1921, 2, 229, 340). In this region of the Cape Province the sweet potato is grown as food for both man and stock, and attention is now directed to the possibilities of utilising it for

the production of fuel alcohol. Climatic conditions, soil, varieties, cultivation, propagation and harvesting are described, the account being based largely on the results obtained on a farm in the George Division with 80 acres of sweet potatoes. The tuber attains perfection in light sandy loam with a more clayey, well-drained subsoil, but the crop adapts itself readily and it is considered possible that in extending the cultivation good yields might be obtained from unpromising areas consisting almost of pure sand, such as the southern coastal soils, provided that suitable manure is applied. The sweet potato plant requires a considerable amount of potash, and in its cultivation rotation is essential, not only as a preventive of soil exhaustion and a means of increasing the yield, but also as a means of controlling diseases of the crop and generally improving the soil.

As a raw material for the production of industrial alcohol it is claimed that the sweet potato is more easily grown and is a cheaper starch producer than the common potato. The latter contains about 75 per cent. of water, and yields from 16 to 24 per cent. of starch, while the sweet potato contains 72 per cent. of water and approximately 25 per cent. of starch and sugar. Analyses of soils and tubers are given in the article, together with yields per acre, cost of production, and a description of methods of cultivation and experiments carried out in other countries.

Root-Pruning of Cocoa Trees.—In *Agric. News* (1920, **19**, 404) an experiment carried out in the Botanic Gardens, Dominica, in 1920 is brought to the notice of investigators dealing with the problem of poor-yielding trees as indicating a line of work which might afford much useful information. Of two poor-yielding cocoa trees in a certain plot in the Gardens, one was judiciously root-pruned and yielded that season 78 fully-grown pods, while the untreated tree carried only 14 pods. In this experiment only a few roots about the thickness of a lead pencil or slightly less were cut, but as such roots ramify into hundreds of feeding rootlets, their severance was apparently sufficient to give the shock necessary to bring the tree, which was of good vegetative vigour, into improved bearing condition. Careful trials on a larger scale are advocated, and it is pointed out that root-pruning would be a simple process and more likely to be adopted by planters than the budding of established trees. The latter is a method of remedying poor yielders which has been examined by the Agricultural Department, Trinidad, and consists in cutting back the

branches of unprofitable trees and budding upon the young shoots a variety known to be a good yielder. This method requires trained labour and careful attention subsequent to budding, while the cutting back of large branches of cocoa trees is attended with some danger. Further it is by no means certain that the very low yielding character of healthy, vigorous specimens is inherent, but it may be due to a cause or causes, the investigation of which may reveal a simple method of overcoming the defect, without recourse to the tedious work of the top budding of established trees.

Cocoa Husks and Meal as Fodder.—A short account in *Agric. Gaz., New South Wales* (1921, **32**, 55) summarises the recent work by the Department of Agriculture and other workers on the poisoning of stock through feeding on cocoa meal or husks. Analyses show the husks to contain about 1 per cent. and the meal about 1½ per cent. of theobromine, an alkaloid which in small doses acts as a stimulant, but in larger amounts has a toxic action. It has been found in the case of horses that 3¼ lb. of husks per day for four days caused death, whilst a heavy mortality ensued amongst ducks after the introduction of cocoa meal into the mash. Cows, rabbits, pigeons and fowls have also been poisoned with these materials, and although both the husks and meal contain a high percentage of albuminoids and a fair amount of fat, the use of the husks as a feeding-stuff is not to be recommended, while the meal should not be used except in small quantities.

The results of analyses of cocoa husks and reference to cases of poisoning caused among horses by their use are also given in *Bull. sci. pharmacol.* (1920, **27**, 355, abstr. in *Chem. Abs.* 1920, **14**, 3114).

Kikuyu Grass.—This grass was first brought to notice by Mr. David Forbes, who collected a single root of it on the shores of Lake Naivasha, Kikuyu, in 1911. This root planted in one of the plots of the Botanical Station of Groenkloof, Pretoria, quickly established itself, and the plant has since been tried as a pasture grass in the Transvaal and Mashonaland, and also as a lawn grass. The grass was originally identified as *Pennisetum longistylum*, but is now described as *P. clandestinum*, Hochst. ex. Chiov. (*Kew Bull.*, 1921, No. 2, p. 85). The grass is a low, closely matting perennial with a creeping rhizome throwing up short stout branches. The leaves are flat and spreading, and under moist conditions the grass will grow to 2½ or 3 feet in height, and yield two or three cuttings per season. As yet it has

not been observed to set seed in South Africa, and it is best propagated by lifting the grass in sods, cutting these into pieces about three inches square and planting them out six feet apart; under these conditions on fairly good soil, the grass will cover the ground in one season. Being a summer grass, the best time of planting is during the spring or summer rains. It grows well on any soil, but thrives best on moist vlei soil. On the red soils of Mashonaland, the grass adapted itself to local conditions and proved a highly satisfactory pasture grass. It is stated to be one of the most palatable grasses and readily eaten by stock. According to an analysis made by the Division of Chemistry, Pretoria, Kikuyu grass has the following percentage composition: Moisture, 8·29; protein 12·36; carbohydrates, 35·06; fat, 1·7; crude fibre, 33·08; and ash, 9·42; which shows it to be one of the most nutritious of South African grasses. Its disadvantages are (1) that it is a summer grass and will not remain green throughout the winter unless watered and not exposed to frost, (2) the likelihood of Kikuyu pasture becoming sod-bound, and (3) the danger of such vigorous growth impoverishing the soil. Kikuyu grass is a persistent grower and will establish itself against any of the veld grasses of minor feeding value. On account of its ability to grow on practically any kind of soil and its creeping characteristics, it should be an excellent soil-binder on dam walls and slopes liable to erosion. It is also recommended for planting in poultry runs, and ornamental lawns have been grown with the grass on the terraces of the Union Buildings, Pretoria.

Oils and Oil Seeds

Argan Seeds.—The possibility of exporting the kernels of *Argania Sideroxylon* from Morocco to France as a commercial source of oil is discussed in *Les Matières Grasses* (1921, **13**, 5,757). The dry fruits of this tree consist of 33 per cent. of pericarp and 67 per cent. of nuts. The dry nuts are composed of 90 per cent. of shell and 10 per cent. of kernels, which contain 50 per cent. of a pale-coloured non-drying oil. It is not considered advisable to count on these kernels as a commercial source of oil, as they are much valued by the natives of Morocco, and there would not be sufficient labour to harvest them in large quantities. Further, it is recommended that it would be preferable to develop the cultivation of olives if it is desired that Morocco should assist in providing France with an increased supply of vegetable oils.

Cantaloup Seeds.—The seeds of the cantaloup (*Cucumis Melo*, Linn.) have been examined and found to yield 30·4 per cent. of a pale yellow oil with a pleasant odour and taste (*J. Amer. Chem. Soc.*, 1920, **42**, 2,398, abstracted in *Analyst*, 1921, **46**, 51). This oil is semi-drying and gave the following constants: Iodine value, 125·9 per cent.; saponification value, 192·3; specific gravity at 25/25° C., 0·9210. Senat seeds, the product of a closely related species of *Cucumis* from the Anglo-Egyptian Sudan, examined at the Imperial Institute contain an oil of similar appearance and possessing similar constants (cf. this BULLETIN, 1913, **11**, 58).

Coconuts.—The subject of the interplanting of trees on coconut estates is discussed in a recent number of the *Poona Agricultural College Magazine* (abstracted in the *Planters' Chronicle*, 1921, **16**, 209). The results of observations made in the coconut estates in Goa are recorded and lists are given of the trees that have a detrimental effect on these palms when interplanted among them and also of those that have a beneficial effect. In Goa the coconuts generally grow on lateritic or sandy alluvial soils that are lacking in humus. The subsoil is very often compact and contains too much moisture. Therefore, deep-rooted trees when interplanted tend to remove this excess of moisture, while rotting foliage helps to increase the amount of humus. Other advantages of interplanting are: the effect of the trees on the distribution of the rainfall, their function as wind-breaks and their protection of the soil from the excessive heat of the sun. Care should be taken that the interplanted trees do not overcrowd or overshadow the coconut palms.

Stockdale in the *Tropical Agriculturist* (1921, **56**, 94) describes the diseases which affect the coconuts in the Kurunegala district of Ceylon. The chief diseases are leaf-droop, nut-fall and leaf-break. The first two are believed to be caused by the same fungus, a species of *Phytophthora*. These diseases occur on both well cultivated and neglected estates, where the rainfall is heavy for coconuts, and may cause considerable damage in excessive and continuous spells of wet weather. Bud-rot also is ascribed by some mycologists to a species of *Phytophthora*. Leaf-break is considered to be caused by a species of *Diplodia*, and in some instances may be associated with a diseased condition of the bud. It is most common in plantations where the agricultural conditions are not entirely satisfactory, and may be looked upon as a "deficiency" disease (see this BULLETIN, 1920, **18**, 441). The

remedies recommended are: good cultivation, better drainage, the collection and destruction of all fallen diseased nuts and leaves, and the spraying of the palms as a preventive measure. Stockdale considers that spraying should be carried out during the north-east monsoon; the area should be sprayed completely within the first month and the operation repeated not less than six weeks later. In a prolonged wet season a third spraying might be found advisable. Whether spraying should be carried out during the south-west monsoon requires further observation.

The total output of coconuts in Trinidad and Tobago during 1919 was over thirty-six million nuts (*C. O. Reports, Annual*, No. 1,069, *Trinidad and Tobago, Report for* 1919 [Cmd. 1,103–12], 1921). Of these, thirty million nuts were exported in the shell, while the remainder (1,795,033 lb.) was shipped as copra. The respective values were £322,423 and £34,875. The total output shows a slight decrease as compared with that for each of the two previous years. This decrease may be due to the fact that a larger number of nuts had been used locally for native consumption. Coconut cultivation is rapidly extending in this Colony, and there is every promise of a considerable increase in the output in the course of the next few years. Greater attention is being given to tillage, and animal-drawn implements and even tractors are being employed.

Bulletin des Matières Grasses (1921, No. 2) is chiefly devoted to an article on the cultivation of the coconut palm in Dahomey. The palm is not indigenous to this part of West Africa, but was introduced long ago by the Portuguese, and only during the last ten or fifteen years has the cultivation been developed by the establishment of regular plantations. It is estimated that there are 150,000 palms in bearing in Dahomey, that an equal number of young palms will come successively into bearing during the next few years, and that 640,000 more might be planted in suitable areas. The palms reach their maximum production when between twelve and fifteen years old, a vigorous and healthy tree giving from sixty to eighty nuts per annum. Seven nuts will yield 1 kilo. of sun-dried copra. For several years past the Agricultural Service has been encouraging the natives to extend the cultivation of the coconut by giving them concessions, distributing seed and paying bounties. The most suitable zone for future plantations is the coastal belt where the soil is sandy. In other districts termites abound and cause considerable damage to the young plants. It is recommended that the land to be utilised for new plantations should be planted for the two previous years with

manioc. The seed is sown in nurseries and when the seedlings are one year old they should be planted out seven to eight metres apart, preferably at the beginning of the rainy season. The soil should be well looked after and the lowest leaves of the young palms taken away as they wither. Care should be taken to prevent attack from the *Oryctes rhinoceros* beetle. It is considered that the extension of the cultivation should be left to the native planters, who could readily plant 20,000 to 30,000 fresh trees per annum, and at this rate the maximum area would be covered in thirty years. It is recommended that a central factory under European supervision should be erected for the preparation of copra and for the utilisation of the coir, which is at present discarded. By this means a better copra would be produced, the native prepared product being often sandy and insufficiently dried.

Ground Nuts.—Australia imports annually about 2,000 tons of ground nuts and 250,000 gallons of ground-nut oil from the East. According to the *Oil and Colour Trades Journal* (1921, **59**, 2,274), the growing importance of these nuts as a source of oil has induced enterprising Australians to undertake the experimental cultivation of ground nuts in Australia, and the district of Cooktown, Queensland, has been selected for this purpose. The soil in this area is considered suitable while the climate in the uplands is equable and comparatively cool, is free from frost and has an abundant rainfall. Experiments already made have shown that ground nuts can be successfully grown in this district, some of the samples examined containing 51 per cent. of oil. This initial success is to be followed up by operations on a larger and more systematic scale. Two varieties are to be cultivated, the larger Chinese sort and the Red Spanish. The first-grade nuts will be marketed for ordinary edible purposes and for use in confectionery, while the second and the third grades will be crushed for oil.

Oil Palms.—The export of palm oil from Sierra Leone during 1919 was greater than that for any of the last ten years and reached 828,750 gallons, of which 819,375 gallons went to the United Kingdom. The price of a ton of palm oil at Freetown at the close of the year was £48, and the high prices realised during the year were sufficient stimulus to ensure adequate supplies (*C. O. Reports, Annual,* No. 1,065, *Sierra Leone, Report for* 1919 [Cmd. 1,103–8], 1921).

As regards palm kernels in this Colony for the same year, the conditions were more favourable for harvesting,

the shipping facilities were more regular and the supply of labour adequate. The quantity exported was 50,622 tons, an increase of 9,806 tons over that for 1918. At the close of the year the price of the kernels at Freetown was £25–£26 per ton.

Olives.—In the *Administration Report of the Punjab* for 1919–20 it is stated that in the olive plantation at Khairimurat during the period under review only 500 out of the total of 10,821 trees bore fruit, the weight of the crop being 15 maunds (about half a ton). All the trees were pruned as against 4,300 in the previous year, and the results of an experiment in which twenty-one trees were specially heavily pruned were good, nineteen of the treated trees having borne fruit. The experimental extraction at the Dehra Dun Forest Research Institute of oil from the fruit grown in the Khairimurat plantation was somewhat handicapped by the fact that a suitable press had not been erected, but the results obtained were sufficiently satisfactory to warrant a further experiment being made.

Tung Oil.—With a view to developing the cultivation of the Tung oil tree in the United States of America, and so making that country independent of foreign supplies of Tung oil, various areas in the Southern States have been inspected to ascertain their suitability for the growth of the tree. Extensive plantings already made by the Agricultural Department have shown that the Tung oil tree can be successfully grown in the United States (*Circular No.* 123, 1921, *Educ. Bur., Paint Manuf. Assoc., U.S.A.*). One of the most suitable areas is situated about 150 miles west of New Orleans. The land at this place was originally part of the bed of the Mississippi river and is at the present time covered with rich alluvial soil. It is suggested that existing cotton seed crushing plants might be utilised for the expression of the Tung oil, while turpentine plants could be used for the extraction of the oil by solvents. The *Circular* contains a list of the Tung oil plantations in the United States, a description of a few of them, and the results of analyses of samples of fruits grown in that country.

Xanthium echinatum.—The seeds of *Xanthium echinatum* contain 30·7 per cent. of kernels, which yield 29·9 per cent. of oil with an iodine value of 140·8 per cent. and saponification value of 190·2. A film of the cold-pressed oil dried in five days, linseed oil under the same conditions requiring only four days. The press-cake is stated to

contain some toxic principle, which renders it harmful to cattle (*Les Mat. Grasses*, 1921, **13**, 5,769).

Miscellaneous.—The papers on the subject of "Oils and Oil Seeds" which were submitted at the Congress of Colonial Agriculture, held in May 1918 in Paris under the presidency of M. J. Chailley, have recently been published for the Union Coloniale Française by A. Challamel, Paris, under the title of "*Congrès d'Agriculture Coloniale* 1918, *Compte Rendu des Travaux, Tome II, Section des Oléagineux.*" These papers deal with the general question of the extension of the cultivation of oil seeds in the French Colonies together with detailed accounts of their cultivation in the various French Possessions. The oil seeds mentioned include: Ground nuts, palm fruits, coconuts, olives, sesame seeds, castor seeds, and shea nuts. A final chapter is devoted to an economic study of the cotton-seed industry.

FIBRES

Jute.—A paper, entitled "Studies in Diseases of the Jute Plant, (1) *Diplodia Corchori*, Syd.," by F. J. F. Shaw, D.Sc. (Lond.), A.R.C.S., Second Imperial Mycologist, has been published as *Memoirs of the Dept. Agric. in India, Botanical Series* (1921, **11**, No. 2).

The disease, caused by the fungus, *Diplodia Corchori*, Syd., was observed in 1917 on an area of the Pusa Farm planted with "kakya bombai," a pure line race of jute selected by the Fibre Expert to the Government of Bengal (cf. this BULLETIN, 1917, **15**, 585). When the plants had reached a height of 10–12 feet, some of them showed signs of wilting, and a dense black band was noticed round the stems at a point about 2–3 feet from the ground. This black band gradually increased in density and spread both up and down the stem. The affected plants ultimately shed all their leaves and were left standing as dry black stems. The disease was also found to be prevalent among plants grown for seed in the neighbouring indigo factories and at more distant centres in Champaran.

A crop of "kakya bombai" in Kamrup, Assam, was also affected by the fungus, and it was found that the number of plants attacked was much greater in the thinly-sown portion of the area where the jute was being grown for seed, than in the more thickly-sown part in which it was being grown for fibre. Similar observations have since been made in other parts of Bihar and Assam and also in Bengal, and the disease is evidently diffused over the whole of the jute-bearing area.

It appears that only stems of a certain size and maturity are liable to infection, thin and short stems being practically free from the disease. The disease occurs after the plant has flowered, and its intensity varies greatly in different seasons. It is most severe on large, well-grown stems, and infection takes place more readily on green-stemmed than on red-stemmed varieties. Late-sown crops are more resistant to the disease than early-sown crops. Further research is needed to determine the precise mode of infection, the conditions of temperature and humidity under which it takes place, and the particular qualities which render the late-sown plants resistant to attack. Fortunately, the jute crop of India is generally free from fungoid disease and *Diplodia Corchori* is not a source of danger to the industry.

There is another stem disease of the jute plant, which is caused by a fungus known as *Macrophoma Corchori*, Saw., and this will be dealt with by the author in a later communication.

Mauritius Hemp (*Furcræa gigantea*).—It is stated in *Colonial Reports, Annual, No.* 1062, *Mauritius, Report for* 1919 [Cmd. 1,103–5], 1921, that the "aloe fibre" or Mauritius hemp industry, which a few years ago was regarded as of great promise, has declined owing to the competition of sugar growing, land formerly devoted to Mauritius hemp being increasingly planted with sugar-cane. Attention is being given to the possibilities of Sisal hemp cultivation in the island and trial plantations have been established, but although certain lands appear to be well adapted to this crop the planters do not regard it with much enthusiasm. The production of Mauritius hemp was continued throughout the war, but the industry was hampered by lack of shipping facilities. The exports of the fibre during 1919 amounted to about 2,177 metric tons of value Rs. 782,285, as compared with 391 tons in 1918 of value Rs. 140,135.

Sisal Hemp and other Agave Fibres.—In view of the importance of the supply of binder twine to the grain-producing industries of the United States, consideration has recently been given by the United States Department of Agriculture to the need of ensuring the production of the necessary fibre, either within the United States or in countries over which the United States exercises political control. The present annual production of about 2½ billion bushels of grain crops demands about 200 million lb. of

binder twine, without which the harvesting machines cannot be operated. The greater part of the binder twine is made from henequen (*Agave fourcroydes*) and Sisal hemp (*A. sisalana*). More than 90 per cent. of the total supply of these fibres is now obtained from Yucatan, Mexico, and this dependence on one small State of a foreign country, which is exceedingly liable to political disturbances, constitutes a grave danger to American agriculture.

Efforts have therefore been made during the last three or four years by the United States Department of Agriculture, in co-operation with the Philippine Bureau of Agriculture, to encourage the increased production of binder twine fibres in the Philippine Islands, and an account of " The Production of Binder-twine Fibre in the Philippine Islands," by H. T. Edwards, has been published as *Bull. No.* 930 (1920), *U.S. Dept. Agric.* It is pointed out in this publication that the Philippine Islands possess all the requirements for the development of a large Sisal hemp industry, as they have large areas of unoccupied Government land, a fairly abundant supply of relatively cheap labour, good roads, and cheap transport between the islands. Moreover, Sisal hemp plants are already widely distributed in several different provinces.

For many years, maguey fibre (*Agave Cantala*) has been exported from the Philippine Islands, and, owing to the encouragement given to this industry by the Bureau of Agriculture, the exports increased from 875 tons in 1901 to 15,639 tons in 1916. During the four years 1916–19 the average area devoted to the cultivation of maguey and Sisal hemp plants amounted to about 30,000 hectares (74,000 acres). The leaves are harvested at irregular intervals ; when the prices of fibre are low, the plantations are neglected ; but when high prices are ruling, all available leaves are harvested without regard to whether they are ready for cutting. The leaves are cut into narrow strips, which are made into small bundles and immersed in sea-water for a week or two. When sufficiently retted, the leaves are scraped, beaten on stones, washed in salt water until all the pulp has been removed, and then dried in the sun. The fibre produced in this way is greatly inferior to machine-cleaned fibre, and in 1917 its use for the manufacture of binder twine was discontinued. This temporary loss of the United States market has stimulated the interest of planters in the use of machinery, and may therefore serve to promote, rather than to retard, the development of the maguey industry.

By the co-operation of the United States Department of Agriculture with the Philippine Bureau of Agriculture

to which reference has already been made, information has been disseminated in the islands regarding the possibilities for increased production of maguey fibre and Sisal hemp, instruction has been given on the introduction of improvements into the plantations, and field demonstrations have been carried out. Machine cleaning has been established on a commercial basis, and twelve large modern fibre-extracting machines were purchased by Philippine planters during the eighteen months ending December 1920. Sisal hemp bulbils to the number of 500,000 have been imported into the Philippine Islands from the Hawaiian Islands, and there is now sufficient material available to provide an abundant supply of plants for the future. The plantations are making fair progress, although no very great improvements in the conditions are yet observable.

During the first five months of 1920 the production of maguey fibre and Sisal hemp in the Philippine Islands was greater than during any similar period previously, and amounted to approximately 20 per cent. of the henequen production of Yucatan.

Paper-making Materials

Typha angustata.—In the *Rep. Dept. Industries, Madras, for the year ending* 31*st March*, 1920, reference is made to an investigation of the possibilities for paper-making of jammu grass (*Typha angustata*), which grows in the Kellair lake in the Kistna district. Samples of the grass were collected and forwarded to the Government Agricultural Chemist and to a large firm of paper manufacturers in this country. It was found that the grass is unsuitable for paper-making as the percentage of cellulose is only about 30 per cent. as compared with 48·25 per cent. in the case of esparto grass. Moreover, the fibre is short and weak and the grass becomes brittle as it dries.

Cotton

Uganda.—An account of the progress of cotton growing in Uganda is given in the *Ann. Rept. Dept. Agric., Uganda Protectorate, for the year ended* 31*st March*, 1920. The industry is firmly established and a steadily increasing production is anticipated. The total area devoted to cotton amounted to 163,846 acres, of which 162,351 acres were planted by natives; of the remainder, 1,120 acres were cultivated by European planters, 285 acres by the various Missions, and 90 acres by Indian planters.

The area under native cultivation was distributed as follows:

Eastern Province	*Acres.*	*Northern Province*	*Acres.*
Busoga District	28,000	Masindi District	1,617
Bukedi ,,	23,000	Hoima ,,	4,505
Teso ,,	39,000	Gulu ,,	1,000
Lango ,,	16,000	Kitgum ,,	50
	106,000		7,172
Buganda Province		*Western Province*	
Mengo District	27,000	Toro District	500
Entebbe ,,	5,999	Ankole ,,	1,200
Masaka ,,	11,700		
Mubendi ,,	2,780		
	47,479		1,700
		TOTAL	162,351 acres

The 1919–20 crop was the largest yet produced in any one season in Uganda and amounted to 45,730 bales of 400 lb. each. This figure represents the cotton actually purchased, and was contributed by the different provinces as follows: Eastern Province, 31,735 bales; Buganda Province, 13,550 bales; Northern Province, 345 bales; and Western Province, 100 bales.

The cotton was, on the whole, of very good quality, and realised prices in Liverpool which were much in advance of "middling" American.

The quantities of cotton exported from Uganda during the five years ending 1919–20 are shown in the following table:

Year.	Quantity. *Bales of 400 lb.*	Value. £
1915–16	26,226	245,426
1916–17	21,832	348,914
1917–18	27,854	537,631
1918–19	27,492	965,951
1919–20	36,530	1,209,663

The greater part of the cotton is shipped to Liverpool for sale, but a considerable quantity is exported to India. The exports to India during the five years were as follows:

Year.	Quantity. *Bales of 400 lb.*	Value. £
1915–16	3,269	30,251
1916–17	6,472	104,271
1917–18	7,632	228,999
1918–19	14,936	519,645
1919–20	12,084	412,550

Many new ginneries have been erected, and there are now fifty-eight ginneries in existence, of which forty are in the Eastern Province and eighteen in Buganda Province. Some of the ginners are not sufficiently acquainted with the best methods of handling and ginning cotton, and it is intended that this matter shall receive more attention under a system of licensing of the ginneries.

Efforts are made by the Department of Agriculture to instruct the growers in the best methods of handling their crops. They are taught to keep the clean cotton apart from the stained and dirty cotton when picking and to market the two kinds separately. This procedure is well carried out in the Buganda Province, but in the Eastern Province, with the exception of Busoga, sufficient care is not exercised, and consequently the proportion of second-class cotton is unduly high. Unfortunately, in some parts of the Eastern Province, buyers are so keen to purchase cotton that they give the same price for stained and dirty material as for clean white cotton, and there is therefore no inducement to the grower to keep the two separate.

The natives are also instructed not to plant cotton on the same land in two successive years, but as soon as the crop has been gathered the plants are to be uprooted and burnt and food crops are then to be planted immediately. This practice is necessary to reduce the risks of famine.

Selection work in cotton has hitherto been carried out by the Department of Agriculture in the Teso District, but unfortunately the temporary office was struck by lightning during the year under review and all the records were destroyed. Permanent buildings are now to be erected on the Serere Station, and selection work is also to be started at Bukalasa in Mengo District, Buganda Province.

The whole of the cotton seed for planting is provided free of charge by the Government, and, in 1919–20, 23,030 bags of 56 lb. each were distributed. The quantity distributed for the 1920–21 season was so large as to justify the expectation that the production would be increased by about 25–30 per cent.

Difficulty has been experienced with regard to the disposal of the cotton seed, as its export cannot be effected except with very low shipping rates. During 1919–20, however, 5,273 tons were exported as compared with 1,662 tons in the preceding year. As the production of seed in 1920–21 was expected to exceed 40,000 tons, it is evident that the question of its utilisation is of great importance. The East Africa Protectorate and the Union

of South Africa appear to offer good markets for the seed, but at present it cannot be exported to South Africa in bulk. It is hoped, however, that arrangements will be made for Uganda cotton seed to be admitted into the Union of South Africa on condition that it is used within one month for manufacturing purposes.

The pink boll-worm (*Pectinophora gossypiella*) has not hitherto been observed in Uganda, and efforts are being made to avoid its introduction. With this object, the importation of cotton seed and seed-cotton is totally prohibited, and also the importation of ginned cotton from Tanganyika Territory.

West Indies.—In the *Rep. Dept. Agric., Barbados, for* 1919–20, reference is made to the experiments which are being carried out with a view to the improvement of the locally grown varieties of Sea Island cotton in both quality and yield. During 1919, the demand for seed of specially selected Sea Island cotton was much less than in the previous year owing to the high price of sugar, which caused growers to devote their land to sugar-cane in preference to any other crop.

Special attention has been given to the improvement by cultivation and selection of a native variety of Sea Island cotton. This variety appears to be immune to all fungoid diseases and to all insect pests with the exception of the cotton caterpillar (*Alabama argillacea*, Hubn.).

Experiments in connection with the selection of Sea Island cotton are also recorded in the *Report of the Virgin Islands Agricultural Expt. Station*, 1919. An effort is being made to obtain a variety which will combine high productivity with extra long and fine fibre. The work which has now been in progress for eight years has resulted in a marked improvement in these respects in the cotton grown in the Island of St. Croix. Nearly all the cotton planted in this island is pedigree cotton obtained from the experiment station, and one plantation is reported to have obtained a crop of 60,000 lb. of seed-cotton from an area of 50 acres. Efforts are also being directed to the production of a variety of Sea Island cotton resistant or immune to blister mite and some progress has already been made.

India.—In the *Rept. on the Operations of the Dept. Agric., Punjab, for the year ending 30th June*, 1920, reference is made to the progress of the cultivation of American cottons. The area planted with American varieties is estimated at 500,000 acres. In 1919, the American crop

suffered severely owing to the prevalence of excessive drought in August, September and October, but, in spite of this, many zamindars and estates obtained a higher average yield than in any previous season. It is estimated that the cultivation of 4F cotton caused a loss of 70,000 bales, as it suffered very severely, especially in the Lower Chenab and Lower Jhelum colonies. The variety known as No. 285 withstood the adverse climatic conditions better than 4F, and was planted in 1920 on about 150 acres. It is considered that this variety is very promising in comparison with 4F, as its superior quality would compensate for a smaller yield, if such were obtained.

Mesopotamia.—In this BULLETIN (1920, **18**, 73) an account was given of cotton growing in Mesopotamia with special reference to the experiments which had been carried out with a number of different varieties to determine the most promising kind for cultivation on a large scale.

An interesting article on the experimental work conducted during the last three years as well as on the commercial and political aspects of the industry has been published in the *Near East* (1921, Feb. 17, p. 207; March 3, p. 268; May 5, p. 542; and May 12, p. 569). It is stated that the work so far carried out has shown that three of the varieties tested are well adapted for cultivation, and that two of these are of Egyptian and one of American origin. It is hoped that at the end of the present season the authorities will be in a position to decide definitely which variety will be distributed for commercial cultivation during next season. The cotton which appears best suited for general distribution is a variety imported into India from South Carolina under the name of Webber 49. As the characters of this cotton have been changed to some extent from those of the original cotton as grown in the United States, it has been termed "Mesopot White."

During 1920, an attempt was made by an Arab sheikh and his cultivators to grow Mesopot White on an area of eighty acres. This trial was supervised and financed by the Agricultural Department. The results were adversely affected by the disturbances which took place in the country, necessitating the compulsory withdrawal of the supervisory staff. In consequence of this, the crop, instead of being irrigated at intervals of ten days until the end of September, was not watered after the middle of August. In spite of this treatment, however, an average yield of 1,250 lb. of seed-cotton per acre was obtained. In addition to this trial, about 400 acres were planted by estate owners with Egyptian cotton. On the whole of this area the crop

gave promise of good returns, but during the disturbances the plants were neglected and most of the cotton was stolen.

The opinion is expressed that there is a sufficient supply of Arab labour available for the cultivation of the whole of the areas at present irrigable, and that as more land comes under irrigation the incursion of Arabs, more especially from Southern Arabia, will probably keep pace with this extension.

The development of the industry is being carried out under the guidance of the Agricultural Department mainly in the interests of the Arab population, and the British Cotton Growing Association is rendering valuable assistance by the erection of ginneries. There is now sufficient seed of Mesopot White available for distribution to plant about 2,000 acres.

The author of the article points out that the results of the attempts to grow cotton in Mesopotamia on a commer-mercial basis have shown (1) that the industry would provide full-time occupation for the Arabs throughout the summer months; (2) that even with irregular and inefficient treatment the crop can give a yield equal to the average obtained in Egypt; (3) that the Arabs can readily be taught to cultivate cotton in the intensive manner adopted in Egypt; and (4) that cotton growing on an extensive scale would contribute largely to the material welfare of the cultivating class, to the expansion of trade, to the prosperity and revenues of the country in general, and, indirectly perhaps, to the maintenance of peace and order.

Philippine Islands.—In the *Philippine Agric. Review* (1920, **13**, 186) an account is given of the possibilities of creating a large cotton-growing industry in the Philippines. It is pointed out that several species of cotton are already present in the islands, and that at one time cotton cultivation was conducted on a fairly large scale in Ilocos, La Union and Batangas Provinces. At the present time, some cotton is still grown and is woven into native cloths in Ilocos and Batangas. The soil and climate of the Philippines are well adapted for cotton cultivation. Good varieties of cotton appear to be already acclimatised to certain parts of the islands and are more or less resistant to insect pests. Success in cotton growing would probably lead to the establishment of factories and would consequently reduce the quantity of manufactured cotton goods imported. It is also possible that an export trade in raw cotton might be created, particularly with Japan. There is ample labour available for growing and picking the

cotton, and wages would be much lower than in the United States. It is therefore concluded that the Philippines could grow cotton much more cheaply than other countries and could export the crop to Japan at a comparatively low rate of transport. The author of the article recommends that the Philippine Government should undertake a thorough investigation of the relative suitability of different varieties to the climatic and soil conditions of the islands and a careful study of insect pests and diseases with special reference to methods of controlling them.

FORESTRY AND FOREST PRODUCTS

Commercial Woods of Mysore.—In view of the fact that arrangements have been made for the consignment to the European market of about a dozen kinds of timber and cabinet woods from Mysore, G. R. Keen, in the *Timber Trades Journal*, 1921, p. 1125, gives a general account of that State and particulars of the chief timbers. He describes Mysore as having a general elevation of 2,000–3,000 feet, and draining by the Krishna and Cauvery into the Bay of Bengal, with streams suitable for timber transport. The climate being temperate, with a rainfall in the rich forest tracts of 50–330 inches, it is claimed, not only that there are both deciduous and evergreen trees, and that the woods are not—like most of those of India—all hard, heavy and difficult to work, but that some of them produce wood distinctly superior to that of the same species grown in other parts of India. Mr. Keen gives a table of the percentage of moisture, weight per cubic foot, moduli of elasticity and rupture, and hardness of the woods as compared with common American woods. The teak is said to be exceptionally durable because it is not girdled, and to be frequently figured. The rosewood (*Dalbergia latifolia*) is never as black as that of the north, which is known as Bombay blackwood ; but true ebonies (*Diospyros* spp.), sometimes jet black, are procurable in perfect logs 20 feet long. Before the war these went almost exclusively to Germany. Haldu (*Adina cordifolia*), a canary-yellow wood, darkening on exposure, weighing about 40 lb. per cubic foot, moderately hard and easily worked, is suggested for turnery. The so-called East Indian walnuts (*Albizzia Lebbek*, *A. procera* and *A. odoratissima*) are considered to be more decorative and mechanically superior to the totally unrelated European walnut. Finely figured burrs are obtained, and the last-named, which is darker and denser, is recommended for wheelwrights' use. The employment of the name "walnut" for these woods,

though no doubt useful as a means of selling them, is unfortunate, as suggesting technological characters which they do not possess, and the same is true of the name "yellow mahogany" as applied to *Artocarpus hirsuta*. This wood, decoratively equal to mahogany, is said to form a very durable material for boats, resisting both termites and teredos. Both it and the allied jack wood (*A. integrifolia*) darken considerably on exposure. The poons or Alexandrian laurels (*Calophyllum tomentosum* and *C. Inophyllum*) are, of course, well known as excellent wood for spars and masts, and are procurable in logs 120 feet long and 4 feet in diameter. When cut on the quarter, they are very beautiful; but when they are suggested as substitutes for Oregon or pitch pine or American oak, the question of relative price would seem to arise. Gurjun (*Dipterocarpus turbinatus*) also is becoming known as a useful wood procurable in Mysore in large dimensions, and in quantities greater even than those of poon. Cigar-box cedar (*Cedrela Toona*), familiar as Moulmein cedar or as the best of the Chittagong woods, might unquestionably procure a steady demand; but, though in India the species of *Lagerstroemia* may serve as teak substitutes, probably such hard and heavy Indian woods as these, kolaon (*Hardwickia pinnata*), which it is proposed to call Mysore mahogany, and saj (*Terminalia tomentosa*), to which the overworked name Indian walnut is applied, and of which figured burrs are procurable, are more likely to secure a limited market here as furniture woods than for engineering purposes.

Coolibah (*Eucalyptus microtheca*, F. v. M.) **in Western Australia.**—The natives of Western Australia obtain drinking water from the roots of this tree and employ its leafy branches for stupefying fish; but its value is now urged (*Austral. Forestry Journ.*, 1921, **4**, 19) as a substitute for lignum-vitæ for shaft-bearings, bushes for pumps, lining for the stern-tubes of steamships, and bowling-green bowls. The species is one of the more tropical eucalypts, but withstands temperatures ranging from 18° to 156° F. It grows to a height of 80 or even 150 feet, mixed with other species; it is very difficult to work, weighing 82 lb. per cubic foot as against 73 lb. in lignum-vitæ and being harder in proportion.

Forests of Madagascar.—M. Louvel, the chief of the forest service in Madagascar, has recently published an account of the forests of the island, extracts from which are printed in the *Bulletin économique de Madagascar* (1920,

17, 211). The prevalent soil is described as a poor laterite covered with about a foot of humus, and the forests consist of a great variety of species sown by birds and lemurs, and thus much mixed, and, under the extreme struggle for existence, slow in growth and producing heavy timber. Taking a European oak to average 40–50 centimetres in diameter in 180 years, a Malagasy species is estimated to require twice that time to reach the same dimensions. The forest trees average 40 feet in height, but in ravines often exceed 50 feet. On the coast their height is less, but their diameter often greater. Some species of *Tambourissa*, and also *Elæocarpus rhodanthus*, *Calophyllum laxiflorum*, *Nauclea cuspidata* and *Canarium madagascariense* reach a girth of 16 to 22 feet. A stem of nato (*Calophyllum*), 2 feet in diameter, found in a perfectly sound condition below the roots of another of about the same size, and probably 300 years old, indicates that this wood is incorruptible, as also are those of *Tambourissa*, hintsy (*Afzelia bijuga*, the shoondul of India), palisander (*Dalbergia baroni*) and others.

The forests of Eastern and Western Madagascar are described separately, the former being divided into three zones, littoral, median, and mountain or high forest; and the latter into two, littoral and forest; while the woods are grouped as hard woods for cabinet work and inlaying, construction and furniture, sleepers, and special uses, such as carriage-building, wheelwrights' work, turnery, carving, paving, gun-stocks, and wagons, forming 70 per cent. of the forests; and soft woods suitable for packing-cases, firewood, charcoal and paper-pulp. The latter class consists mainly of broad-leaved trees, *Podocarpus Thunbergi*, the well-known yellow-wood of East Africa, being the only conifer in the forests of Madagascar. Ebony and rosewood are stated to have been the only cabinet woods hitherto exported to Europe, the palisander-wood having been used for most of the sleepers on the Tamatave and Tananarivo Railway, and it, the nato and the other valuable species having been recklessly felled for such purposes and even for fuel. The littoral zone on the east is a region of lagoons and swamps, poor in forests, with meadows of short grass, and numerous palms, screw-pines and cycads. The median region, with numberless rounded hills, 30–250 metres in height, was, a few years ago, covered with fine forests, now largely burnt. Their place has been taken by the Raphia palms, groups of bamboo (*Nastus capitatus*), *Ravenala* and *Amomum Daniellii*. The cabinet and furniture woods of these two zones include ebony (*Diospyros Perrieri*), now seldom found large, the best black variety

being known as "Hazomainty ikirina," rose-wood, and hintsy, a valuable species for reafforestation, though slower in growth than eucalypts, but more valuable. Among constructional timbers are the copal or mandrorofa (*Trachylobium verrucosum*), hazomafana (*Diospyros megasepala*), and *Uapaka Thouarsii*. The soft woods include filao (*Casuarina equisetifolia*, the swamp oak of Australia) and atafana (*Terminalia Catappa*, the Indian almond or tavola of Fiji). The mountain, or high forest, zone yields hard cabinet woods such as palisander (*Dalbergia baroni*), sovoka (*D. pterocarpifolia*), vintanina (*Calophyllum parviflorum*), and the allied nato; and a great variety of constructional timbers, including the yellow-wood above mentioned, hazomby (*Erythroxylum myrtoides*), hazomalana (*Payera excelsa*), balona (*Weinmannia Bojeriana*), voanana (*Elæocarpus rhodanthus*), sevalahy (*Piptadenia Pervillei*), and undetermined species of *Canarium*, *Ocotea*, *Eugenia*, *Leptolæna*, etc. Among woods for sleepers special mention is made of hazotokana (*Synchodendron ramiflorum*) and mankaleo (*Dilobeia Thouarsii*); and various undetermined woods are suggested in place of imported pitchpine, teak and mahogany for the building of railway rolling-stock and turnery. Several species of hafotra (*Dombeya*), voara (*Ficus tiliæfolia*) and others are described as having soft white and light woods.

The littoral zone on the west is only about four kilometres in width, and consists largely of mangrove swamps, behind which are extensive sandy flats flooded in the rainy season and exhibiting large areas of saline efflorescence in the dry season. The dunes to the eastward rise four or five metres, giant baobabs occurring among the brushwood that covers them. The forest zone, some forty kilometres wide, is interrupted by extensive plateaux covered with spinous scrub and by swampy hollows. The trees are mostly deciduous, and the tree-ferns, bamboos and orchids of the tropics are absent. The cabinet woods include ebony, or lopinga, which is worked by Hindu merchants, manary (*Dalbergia Ikopensis*), a palisander, nato (*Sideroxylon rubrocostatum*), and a mahogany (*Khaya madagascariensis*) known as hazomena. Among the constructional timbers are the useful bonara (*Albizzia Lebbek*, the so-called East Indian walnut), and tamarind, or kily; and several timbers are well suited for sleepers, such as katrafay (*Cedrelopsis Creosi*), mangarahara (*Stereospermum euphorioides*), tsilaitsy (*Dicoryphe laurifolia*) and tsiavango (*Phylloxylon ensifolius*).

M. Louvel's memoir concludes by urging the necessity of reafforestation in Madagascar to improve the climate,

regulate the water-supply, and enrich the soil, replacing sterilising droughts by abundant dews, besides providing for the future a supply of timber, firewood, charcoal and tanning barks. Experiments have been made at Analamazaotra with ninety-five species of *Eucalyptus*, fifteen of which are specially recommended as yielding valuable results within ten years. The planting of wattles (*Acacia decurrens* and *A. elata*), of the maritime pine, cryptomeria, araucarias, taxodiums, cashew-nut, hintsy, sovoka and other valuable local species is recommended; and free distribution of seed and plants, free grants of denuded land and the assignment of lots of ten and twenty hectares of ground to native schools are suggested.

Teak and other Woods in Celebes.—According to *The Dutch East Indian Archipelago* (1921, **3**, 1143) there are extensive tracts of teak and other kinds of useful timber in Eastern Celebes, and a concession has been granted for working them to a company with headquarters at Raha. The export of teak is stated to have grown from a value of 28,000 florins in 1914 to 122,000 florins in 1919; and the presence of a forester at Raha has led to the recognition of the importance of better roads, fire-prevention and replanting.

MINERALS

Aluminium

Spain.—The Catalonian bauxite deposits are described by Primitivo Hernández Sampelayo in *Bol. del Inst. Geol. de España* (1920, **41**, 3). Various deposits of bauxite are found in an area of about thirty-one square miles in the south-western zone of the Province of Barcelona. They occur in Triassic and Eocene formations. Some of them are in contact with rocks of the Keuper (Upper Triassic) formation, and others are close to or contained in Tertiary rocks. The deposits related to the Eocene are found in the north-eastern part of the Sierra de la Costa, and also above Rubió, in the north-western portion of the area; those enclosed in the Trias are scattered along the synclinal and gully (*barranco*) from Espinagera to San Juan de Medina. There is no essential difference with regard to the class and mode of occurrence of the mineral in the two formations.

The deposits in the north-eastern part of the Sierra de la Costa, from south to north, are: Els Casals, Mas Torrens, Clot de Llop and Ubaga de Soler.

Els Casals Outcrop.—The rocks enclosing the deposits

resemble the marls and limestones, alternating with clays, which form the upper part of the Keuper (Upper Triassic). The bauxite occurs in the form of nodules, surrounded by clay. One analysis of the latter gave the following percentages: silica, 34·40; ferric oxide, 9·85; alumina, 49·15; so that the clay contains a little less silica and a little more alumina than pure kaolin. At the Diana Mine there is a system of violet, red and white argillaceous marls in which the clay containing the bauxite nodules is concentrated. The whole formation is Triassic, with the exception of some limestone that appears to be Eocene. The best sample of bauxite was from this mine, and yielded the following percentages: silica, 3·70; titanium dioxide, 4·65; ferric oxide, 8·15; alumina, 68·70; loss, 14·15. Bauxite to the amount of 2,000 tons has been raised from this outcrop.

Mas Torrens Outcrop.—The deposit is very irregular, the outcrop being divided into two portions by red crystalline limestone. The height is about 6½ feet, the width from 13 to 19½ feet, and the length 33 feet. A sample yielded the following percentages: silica, 11·50; titanium dioxide, 3·76; ferric oxide, 4·00; alumina, 68·03; and loss by ignition, 12·50.

Clot de Llop Outcrop.—This is one of the most important outcrops of the entire zone, many of the visible outcrops (*crestones*) being from 13 to 19½ feet in height, and, with few interruptions, spread over a length of from 98 to 164 feet. Above the deposit, the yellowish and brick-coloured honeycombed limestones (*carñiolas*) crop out. The deposits are (1) pisolitic, (2) enclosed by clay, or (3) ferruginous outside and white within. The dominating mineral is compact, white or reddish, with abundant oolites about two-hundredths of an inch in size. It carries ferruginous nodules from one-fifth or three-quarters of an inch in diameter to the size of the fist. A sample gave the following percentages: silica, 14·60; titanium dioxide, 2·26; ferric oxide, 20·72; alumina, 49·62; loss by ignition, 12·60.

Other similar outcrops, but of less importance, occur at Ubaga de Soler, and rounded pieces of this mineral are found in the gullies that converge to Clot de Miralles. The mineral is oolitic and generally of a red colour, but some is white or rose-coloured, with a conchoidal fracture.

Although the rocks surrounding these formations resemble the Triassic, they can all be referred to the Tertiary, as they rest conformably on the fossiliferous beds of the valley of Miralles, and also crop out on the south side of the Sierra de la Costa. In a place known as Salt del Gos, bauxite occurs in clay, from which 2,000 tons

were formerly raised. Another deposit occurs at Corral de Novell, and yet another in Ancora; all in a formation described as Eocene by Alvera.

Rubió Outcrop.—This deposit is very distinct from the others. It crops out in a fine-grained limestone, upon which rests alveoline limestone, and has a southerly dip. The deposit is about 10 feet high, 40 feet wide, and from 100 to 130 feet in length. The mineral is red outside and white within, of somewhat rough grain, except the outer shell, which is slatey and kaolinised in contact with the limestone. A sample yielded the following percentages: silica, 18·30; titanium dioxide, 1·37; ferric oxide, 18·80; alumina, 48·52; loss by ignition, 11·93. This is the largest single deposit of bauxite hitherto met with in Barcelona. It is possibly of eruptive origin.

The principal Triassic outcrops are at Montori, Puig-Fred, Mas Bolet and Moranta.

Montori.—The bauxite deposits here rest on wine-coloured marls alternating with gypsum. In the Marta mine, bauxite is found in blocks, scattered for some distance and covering about 2½ acres of surface. The general direction is N. 20° W. There are about 500 tons of loose mineral here, and a hut and boundary wells are seen to be made of it. A sample of several hundred tons yielded the following percentages: silica, 9·40; titanium dioxide, 0·96; ferric oxide, 7·00; alumina, 68·19; lime, 0·40; magnesia, 0·10; loss, 14·10. Another sample, red in colour, the first being white, gave: silica, 8·50; titanium dioxide, 0·90; ferric oxide, 15·60; alumina, 60·40; lime, 0·80; loss, 13·60. The ore is pisolitic, the isolated oolites being from two- to twelve-hundredths of an inch in size. On the high part of the hill on which the mine is situated there is a breccia in gritty limestone containing some fragments of red and white bauxite. The mass of bauxite and gritty limestone were consolidated when this breccia was formed.

Puig-Fred.—The whole valley as far as Puig-Fred is excavated in the marly gypsiferous formation which overlies the limestones. In the Nieves Mine the bauxite is white, finely granular and compact, as well as red and pisolitic. Near the house called Can Ferré there is a limestone breccia containing small angular pieces of bauxite.

Mas Bolet.—In the Teresita mine there is an alluvial containing pebbles of bauxite, limestone and many ferruginous nodules, bound by clay, which, on analysis, gave 40 per cent. of silica, and rather more than 30 per cent. of alumina. The ferruginous nodules yielded the following

percentages: silica, 21·10; ferric oxide, 49·00; alumina, 20·00; proving the material to contain too much silica and alumina to be classed as an iron ore.

Moranta.—Bauxite which is pisolitic, as well as white and ferruginous, occurs here. Nodules abound, and the clay surrounding them is lustrous and kaolinised. In the lower part of the district are marls and sandstones with gypsum, which produce the sterile earth called *soula* in the country.

The Catalonian bauxite deposits can be described as a scattering of small outcrops, related to the fractures of the area in which they are contained, without stratification and with a tendency to be enclosed in the rocks. Being, in this respect like some of the Austrian and Italian deposits, investigation should be made along the vanished secondary cordillera—that is to say, along the Mediterranean arc, which has the same geology and the same tectonics as the bauxite zone. Special attention should be given to ferruginous outcrops, particularly if aluminous and pisolitic, as iron deposits of this type have been the precursors of the discovery of bauxite.

The bauxite deposits of Catalonia are of hydrothermal origin, and of Lower Eocene age. But it may be supposed that laterisation occurred at certain points, which process was aided by the higher temperature of the waters.

The bauxite problem in Spain may be regarded as still under investigation. The percentage of silica is high, so that at present the mineral can be used only for obtaining aluminium sulphate, as a refractory, or as a building stone.

Coal

Russia.—The coal deposits in Russia, and particularly those of the Urals, according to V. Gudkov (*Min. and Met.*, June 1921), do not yield coking coal in large proportions. The total reserves have been estimated at 65,000 million tons, including 18,000 million tons of bituminous coal, much of which is in the Kuznetzky district. The aggregate thickness of the coal-seams of that district amounts to 300 feet, as compared with seventy feet in the Douetsky.

Cobalt

Australia.—According to the *Engin. and Min. Journ.*, May 14, 1921, the cobalt mine near Selwyn, Queensland, continues to develop well, and promises to become important. A fifty-ton consignment of ore shipped to England a few months ago has been followed by a recent shipment of thirty tons. From the main shaft, now at a depth of 112 feet, there has been 50 feet of driving on the lode.

Another shaft is being sunk and an underground connection will be made with the other workings. Development is also proceeding from two other shafts. The owners are about to instal a concentrating plant at a cost of £40,000.

Diamonds

Union of South Africa.—" The Alluvial Diamondiferous Deposits of South and South-west Africa " is the title of a paper read by F. C. Cornell, O.B.E., at the meeting of the Colonial Section of the Royal Society of Arts on Jan. 3, 1921 (*Journ. Roy. Soc. Arts*, 1921, **69**, 136).

After reviewing the origin and development of the diamond industry in South Africa, the author discusses the various theories prevailing as to the original source of the alluvial diamonds, the indications by which the diamond prospector is guided, and also the regulations governing the method of obtaining a claim, and its size. The method of working the diamondiferous gravel is explained and it is stated that many thousands of persons, both European and native, are engaged in the industry.

The paper includes a brief reference to the alluvial diamond deposits of South-west Africa (recently German), which are situated along the coast from a little north of the Orange River nearly to Walfish Bay (see this BULLETIN, 1915, **13**, 242). Up to August 1914 about 5,400,000 carats had been extracted of an approximate value of about £9,250,000. The British occupation of the country early in the war put an end to the diamond industry temporarily, and now the whole of the industry has passed under the control of a British corporation, which will regulate output and the marketing of the stones.

Belgian Congo.—Under the title of " Congo Diamonds," the *South African Min. and Engin. Journ.*, April 30, 1921, publishes information regarding the comparatively unknown diamond-bearing area in the Katanga division of the Belgian Congo. This area is referred to as the leading diamond-producing territory of the world, and the annual output of the Belgian-American Société Forestière et Minière du Congo, otherwise known as the Forminière Company, is stated to be about a quarter of a million carats. The growth of the industry to these dimensions has been due largely to United States capital and enterprise, but British interests are also represented in this field through the Tanganyika Concessions and Zambesia Exploring Companies. The article quotes J. F. Morrison, a correspondent to a Philadelphia paper, to the effect that the diamondiferous area is nearly 8,000 square miles in extent

and has scarcely been touched by the prospector. The diamonds being won are found chiefly in alluvial beds, and every creek and river-bed in the area is a potential source of them. A large number of diamondiferous pipes containing the characteristic blue ground have been located, and, while these appear too poor to be profitably worked, they have probably furnished the diamonds now being won from alluvial gravels. The article states that the development of the Congo diamond field must affect the future of the South African diamond-mining industry.

Brazil.—The high-level diamond-bearing breccias of Diamantina, Brazil, are described by David Draper in a paper read before the Geological Society of South Africa (*Trans. Geol. Soc. S. Africa*, 1921, **23**, 43). The original discovery was in 1729 in the Jequitinhonha river-bed near Diamantina. This river rises in the Serra do Espinhaco, a few miles further south, and the district is the greatest known diamond-bearing area in Brazil. The Serra, whose peaks reach 2,000 metres, is composed of beds of quartzite (with conglomerate) and shale dipping about 45° E., the shale having been eroded and forming steep valleys.

The chief diamond-bearing deposits occur as mounds above the water-supply level, and are located at St. João do Chapada, Sopa, Boa Vista, Serrinha and Datas. Of these the Boa Vista is the most extensive and is described in detail by the author as being typical of the whole area. Situated twelve miles east of Diamantina and surrounded by quartzite ridges lies a mound 250 feet in height composed of broken quartz with nodules of limonite, and brecciated sandstones, covered with soil and vegetation. On the north slope, the beds are much disturbed, and dykes intersect both quartzite and breccia. These dykes are so decomposed that their original composition cannot be determined. They are grey, green or yellow and unctuous to the touch, resembling soapstone. The breccia is the diamond-bearing bed. This consists of angular boulders of variously coloured sandstones, soft and crumbly to the touch, of all sizes and scattered indiscriminately, though sometimes roughly bedded and parted by thin layers of finely granular talc. The cement is soft and talc-like and contains egg-shaped pebbles of quartz, much fractured, also magnetite, martite, ilmenite, perovskite, phlogopite, tourmaline, garnets and diamonds. As to the origin of these deposits, the author argues against the fluviatile theories previously advanced by many authorities, and considers that certain areas were subjected to dynamic forces opening fissures through

which the diamond-bearing rock (probably similar to Kimberlite) could reach the surface in a plastic condition, broken fragments of the country rock being entangled and remaining in suspension by reason of their lower specific gravity. Though the high-level diamond-bearing breccias of Diamantina cannot be called pipes (as in South Africa), they are of local origin and so far boring has not led to the discovery of what is at the bottom of any of these deposits. The author concludes by stating that he has recently discovered a small Kimberlite pipe near the town of Patos, and considers that the Brazilian river deposits derive their diamonds from volcanic vents similar to those of South Africa.

Gold

Canada.—The gold-fields of Northern Manitoba, Canada, have been described recently by Reece H. Hague (*Canadian Min. Journ.*, April 1, 1921, pp. 256–257). The Rex Mine, which is the only producing mine at present, has a vein which strikes N.E. to S.W., parallel to Herb Lake, and dips westerly. The richest ore occurred in the 240-foot level, where a porphyry dyke meets the vein. The gold contents are fairly uniform at the Rex Mine, averaging $20 a ton, and are increasing with depth. On the Bingo vein, half a mile from the Rex, a shaft has been sunk to a depth of 150 ft. The ore is said to average $100 a ton. The Northern Manitoba Mine, one mile from the Rex, has a vein, from 6 to 30 in. in thickness, which has been exposed at the surface for a length of 300 ft. A shaft has been sunk 100 ft. on the vein, which dips east 65°. The filling is gold-bearing quartz, associated with arsenopyrite and tourmaline. A car-load of ore from the mine gave returns averaging $81.50 per ton. On the Kiski claim, close to Herb Lake, one vein has been exposed for a length of 700 ft. Arsenopyrite is the typical sulphide ; chalcopyrite and galena also occur, and tourmaline, in irregular veinlets in the quartz, is abundant. According to R. C. Wallace, the Apex group is within the granite area. There is a somewhat indefinite arch-like zone of mineralisation. Extensive silicification has taken place in what appears to be a line of weakness in the granite, and arsenopyrite, pyrite, and some chalcopyrite, with gold, have been deposited with the silica. The width is from 15 to 20 ft. for 1,000 ft in length. The contents in channel samples are reported to range from $1.50 to $24.00 gold per ton.

On another mine, north-east of the Rex, the vein, which is 6 ft. in thickness at the surface, and 3 ft. at the bottom of a 50-ft. shaft, shows arsenopyrite, chalcopyrite

and galena, somewhat sparingly distributed. It has been traced at the surface for 1,000 ft.

Iron

India.—An account of the iron and steel industry of India, by J. Coggin Brown, is published in the *Mining Mag.* of June 1921. The first part of the article is mainly historical, and deals with indigenous methods of smelting iron and producing steel. This is followed by brief notices of the early attempts to introduce modern methods, which have culminated in the successful enterprises of the present day. The developments leading up to the production of iron and steel under modern conditions by the Bengal Iron and Steel Co., whose operations date back to 1889, and the inauguration in 1907 of the Tata Iron and Steel Co. are described and a detailed description of the latter company's plant is included. The joint production of these two companies of iron and steel materials in 1920 is stated to have had a total value of £25,000,000.

Sierra Leone.—In the *Rept. Govt. Geologist, Sierra Leone,* 1918–19, a description is given of magnetite and hæmatite ore occurrences and also of lateritic iron ores in the neighbourhood of Devil Hole, near Waterloo. Only the last appear to exist in commercial quantity, being found in a coastal belt from 400 to 500 yds. wide and at least three miles long. The deposit has been tested by shallow shafts and by trenching, one shaft being still in ore at a depth of 8 ft. The *Report* states that there are well over 3,000,000 tons of this ore. The analysis of a sample gave the following percentage results: ferric oxide, 71·72; titanium dioxide, 14·10; chromic oxide, 0·15; manganese oxide, 0·20; silica and silicates, 10·31; sulphur, 0·03; phosphorus, 0·04; lime, 0·02; moisture, 1·25; oxygen and loss, 2·18.

Canada.—Under the title "Iron Ore in Whitewater Valley, British Columbia," the *Engin. and Min. Journ.*, May 4, 1921, reports that a considerable section of the Clinton mining division, British Columbia, was placed under reserve by the Provincial Government with a view to the possibility of iron ore deposits contained in this area proving sufficiently important to justify the development of an iron and steel industry. Following a report on these deposits by F. J. Crossland, the reservation has now been removed. Mr. Crossland finds the deposits patchy and not more than from 1 to 5 ft. thick. In eight deposits the positive ore is given as 672,700 tons, of which

about half a million tons is on Mount Clure. The probable ore is estimated at 911,000 tons. The quality of the ore, which is a secondary limonite, is good, containing an average of about 50 per cent. of iron and being free from objectionable impurity; but the quantity available is apparently too small to form the ore basis for an iron and steel industry.

According to *Iron and Coal Trades Rev.* for April 1, 1921, the British Columbia Government have entered into a definite agreement with Coast Range Steel, Limited, whereby the Government will pay a bounty not exceeding 3 dollars per long ton on pig iron manufactured from ore mined in the province, and a bounty not exceeding 1½ dollars on iron manufactured in the province from foreign ore. Capital up to £10,000,000 is said to be forthcoming as soon as the agreement is formally completed. In the meantime engineers are investigating the resources of the province to ascertain where conditions generally are most suitable for the establishment of the plant.

Australia.—Under the title "Iron Ore Deposits of Queensland," an interesting article appears in the *Mining Mag.*, April 1921, in which particulars are supplied of the hæmatite ores of Mount Philp and Mount Leviathan in the Conclurry district, and of the magnetite ore of Mount Biggenden, near Biggenden Railway Station and fifty-four miles from Maryborough. A parliamentary commission reported on these deposits in 1917 and recommended the erection of a small blast furnace for smelting the Conclurry hæmatites to pig-iron. Subsequent investigations by the Queensland Mines Department led to a more extensive programme being undertaken, and works, including smelters for pig-iron and steel and a number of coke ovens, are under construction at Bowen. The quantity of ore available at Mount Philp is about ten million tons in sight and at least as much more covered by other formations.

At Mount Leviathan a large part of the hill, which is only about 270 ft. above the surrounding plain, consists of a lode of hæmatite estimated to contain about two million tons.

The magnetite ore at Mount Biggenden is associated with patches of calcite and disseminated bismuth ores. The ore-bodies are represented by one main outcrop separated by a 10-ft. belt of slate from a number of smaller ones. The quantity of good ore is estimated at a minimum of 500,000 tons, with an average percentage of iron, 57·7; silica, 7·7; phosphorus, 0·04; sulphur, 0·13; bismuth, 0·05; manganese, 0·24.

The composition of the hæmatite ores of Mount Philp and of Mount Leviathan are indicated by the following analyses:

	Mount Philp:		Mount Leviathan.		
Iron . . per cent.	56·2	52·8	62·0	56·5	57·1
Moisture at 15° C. ,,	0·2	2·3	0·1	0·1	0·4
Silica . . ,,	19·5	23·0	8·9	17·0	17·5
Phosphorus. ,,	0·023	0·03	0·11	0·08	0·06
Sulphur . ,,	0·010	0·01	0·04	0·05	0·006

Russia.—According to V. Gudkov (*Min. and Met.*, June 1921) the result of recent explorations has been to increase largely the estimate of iron ore reserves of Russia, which are now considered to be as follows: Siberia, 100 million tons; Southern Russia, 900 million tons; Ural Mountains, 500 million tons; Caucasus, 20 million tons; and Central Russia, 900 million tons, making a total of 2,420 million tons, containing about 50 per cent. of recoverable iron. The deposits of Southern Russia are said to be the most important. Two types of ore are found, one being hæmatite, occurring in conjunction with metamorphosed schists in the region of Krivoi Rog. These ores contain from 50 to 70 per cent. of iron and are low in phosphorus and sulphur. Up to November 1917 these deposits were actively worked, and are estimated to contain 100 million tons with 62 per cent. of iron and 300 million tons with 50 per cent. of iron. The other type of ore is found in the Kertch Peninsula, and consists of brown hæmatite, with iron ranging from 38 to 42 per cent. and 1·5 to 2 per cent. of phosphorus. The tonnage available is considered to be about 500 million tons. Siberia is said to contain several possible centres for an iron industry, and the ores consist of both hæmatite and magnetite. In the Caucasus the ore is chiefly magnetite, but hæmatite deposits are also known. The iron deposits of the Urals so far discovered are in the Bogoslovsk district.

Spain.—In the Zona de Nerja, Málaga, Spain, there is a bedded vein (*filon-capa*) of red hæmatite, striking E. 10° N. to W. 20° S. (magnetic), which has been recently exposed at the surface by a trench 100 ft. in length and 16 to 26 ft. in width. Alfonso de Alvarado estimates that there are 240,000 tons of possible ore in this district (*Bol. del Inst. Geol. de España*, 1920, **41**, 29). Average samples assayed from 48·25 to 52·10 per cent. of iron, were low in silica and contained no phosphorus.

United States.—The *Eng. and Min. Journ.*, March 5, 1920, contains information regarding the iron ores of New York State. Much of the ore is of the magnetite variety and low in phosphorus. The principal mines are at Lyon Mountain, where there is a very large body of ore of this type. Mining is carried on at considerable depth, the intention being to make the hoisting shaft 1,200 ft. deep. The beds are flexured to some extent, and more than one method of mining is adopted. A similar ore, but more coarsely crystalline, is found in the form of a great lens at Minneville, and is known as the New Bed. Pitching under this, at a considerable depth below, is another ore-body known as the Lower Old Bed.

About six miles west of West Point is a heart-shaped shoot of high-grade ore dipping at about 19° and extending for 4,000 ft. Near Sterling Lake is a lens-shaped ore-body, dipping under the Lake, and now being mined at a depth of 3,200 ft.

Hæmatite ores in a bed about 32 in. thick and extending over an area of about 25 sq. miles are found near Clinton. The ore contains on the average 48 per cent. of ferric oxide and 6 per cent. of lime. Another hæmatite bed about 20 in. thick is being mined at Ontario Centre in Wayne County.

Under the title "Origin of Adirondack Magnetite Deposits," W. Miller discusses in *Econ. Geology* (April and May 1921) the origin of the deposits of magnetite associated with the granite, pegmatite, and silexite, as well as the older gabbro and hornblende-gneiss, of the Lyon Mountain region. The origin of primary deposits of magnetite is generally attributed either to magmatic segregation or to contact metamorphism of bedded deposits of other oxides of iron or of siderite; but the Lyon Mountain deposits, which are neither true veins nor beds, but chiefly impregnated zones in the country rock, are considered by the author to represent leachings out of the older rocks by residual pegmatitic and silexitic portions of the granite magma. This residual portion, being mobile and under considerable pressure, penetrated the gabbro and hornblende-gneiss, dissolved their iron content to deposit it afterwards as magnetite when conditions permitted. The author advances a number of reasons for this theory, which, however, has been adversely criticised by other authorities.

Lead

Canada.—In the *Summary Rept. of the Geol. Survey of Canada for* 1919, Part E, T. L. Tanton refers to the galena and blende deposits of Dorion township and vicinity in

Ontario. There are several of these deposits, but none appears to be of great importance. In one case the mineralised veins occur in granite and as a stock-work in mica-schist and gneiss, and in another case, that of the Dorion mine, in a brecciated fault-zone cemented with quartz and calcite. In the Ogema mine the lode is a quartz vein cutting a high granite hill. The vein, although carrying a fair amount of mineral, is not now being worked owing to water troubles. The Enterprise mine, also closed down, is in McTavish township near Ancliff. The mineralised vein in this mine is said to occupy one of a series of step-fault fissures. The country rock consists of Nipigon sediments at the surface, but there are granite outcrops a short distance away. In the same township, near the Arctic mine, is the Caribou lode, one of a number of galena-bearing veins in this vicinity. This lode is found at the contact of a vertical dyke of dolerite, which cuts Nipigon sediments, and the vein material occurs as a stock-work of veinlets and as cemented wall-rock breccia, and is locally rich in galena and blende.

Spain.—A description of the deposits of lead and zinc ores in the Sierra de Nerja, Málaga, Spain, is given in a paper by Alfonso de Alvarado entitled " Zona Oriental de Málaga, Notas sobre su Estratigrafía y Descripción de algunos yacimientos metalíferos," in the *Bol. de Inst. Geol. de España* (1920, **41**, 3). In this region a zone of actinolite slates marks the primitive (pre-Cambrian) era. The lowest bed of limestone is highly folded, and impregnated with lead and zinc ores and other minerals, especially actinolite and pyrite. It can be traced for upwards of 1½ miles. The foot-wall is formed of a band of actinolite-slates, which is only occasionally marked by a narrow and irregular clay selvage (flucan). The hanging-wall (limestone) is less defined. The galena is localised in the outcrops and in the roof, but at Bella Plata that mineral occurs in the foot-wall slates. Calamine is distributed irregularly, forming lenticular masses, with a tendency for the rich parts to be localised on the floor. Both carbonate and silicate (hemimorphite) occur ; blende is scarce, and is found at the contact where pyrite abounds. The deposit is not a lode, but it has been formed by replacement, and is limited to the contact-zone of the limestones and slates. There is a series of rich pockets, connected by poor or sterile zones, forming a rosary (Fr. *filon en-chapelet*) where the most important pockets occur.

In the Barranco de Cazadores, the sinuous outcrop of a bed, impregnated with lead and zinc ores, can be traced

in limestone for about 650 ft. The principal gallery has been driven about 400 ft. in length. The face shows a vein of calamine about 18 in. in thickness. The *tierras* (smalls) extracted from the workings on the average contain 12 per cent., and, after sorting, from 40 to 43 per cent. of calamine. In another concession, galena is the only ore; it is found in nodules, embedded in clay, forming a pocket, and probably formed by replacement.

Manganese

Spain.—In the Sierra de Marchamonas, Málaga, Spain, irregular pockets of pyrolusite occur in Jurassic Oolitic limestone. Alfonso de Alvarado (*Bol. del Inst. Geol. de España*, 1920, **41**, 20), in explaining the origin of the deposits, considers there was a partial dissolution of the limestone with precipitation of ferrous and manganous carbonates, which were oxidised later in the upper zone of the fractures. These deposits have been exploited to a certain extent recently.

United States.—A volume of 209 pp. on "Manganese: Uses, Preparation, Mining, etc," is issued as *Bulletin* 173 of the *United States Bureau of Mines.* It consists of a series of contributions on the various features of the manganese industry by C. M. Weld and other officers of the Bureau of Mines. The various uses of manganese as ore, metal and alloy are briefly described, and also the preparation and employment of manganous salts. The effect of the war on the position of the United States with regard to manganese ore supplies is explained and the rapid development of the domestic production of ore is described. The problems arising out of the utilisation of the domestic low-grade ores are referred to, and descriptions of a number of concentration processes, which were more or less successfully applied, are discussed as well as others, which, while still experimental, are promising. The manufacture of ferro- and silico-manganese alloys is described, and the comparative suitabilities of various types of furnace are discussed. The conclusion reached as to electric smelting of manganiferous slags and low-grade ores is that it can only be profitable in times of high prices. The elimination of manganese in steel manufacture is discussed, and while it is concluded that the dual function of hardening and strengthening steel is not possessed by any other element, it is pointed out that the proportion of manganese might be reduced in certain cases without undue sacrifice of these properties. Other interesting points regarding metallurgical practice in the manufac-

ture of manganese alloys are dealt with, and a selected bibliography on manganese deposits in different parts of the world is added.

Argentina.—According to *U.S. Commerce Report*, No. 19, Jan. 24, 1921, a company, which has worked a manganese mine in Argentina for over two years, has recently acquired another mine in that country, which is being actively opened up. The deposit of pyrolusite at both mines is described as a seam from 3 to 8 ft. in thickness, associated with a little white and pink quartz, which occurs in a rift or fissure in the granite. The ore from the older mine in the Province of Cordoba averages from 65 to 68 per cent. of manganese dioxide, and 4 per cent. of iron oxide, and from it in thirty months were produced 6,000 tons of sorted ore. The ore from the new mine at Ojo de Agua, in the Province of Santiago del Estero, shows 75 per cent. of manganese dioxide, and 0·5 per cent. of iron oxide, and in ten months the yield was 1,400 tons of ore. It is anticipated that the two mines will in the near future produce a minimum of 600 tons of graded ore per month, half of which will be available for export, the remaining half being required for the glass and iron industries of the country.

Origin of Manganese Ores.—In the Note on "The Relation between Bacteria and certain Iron and Manganese Ores" published in this BULLETIN (1920, **18**, 551) it is stated that A. O. Hayes found fossil tubules of minute boring algæ in shell fragments, spherules, phosphate nodules and siderite in the Wabana hæmatite of Newfoundland. In the Note attention is drawn to the possibility of algæ, as well as iron bacteria, having been instrumental in the building up of certain deposits of iron and manganese ores. In this connection an occurrence of manganese ore in the Batesville District, Arkansas, U.S.A., is both interesting and suggestive. The Cason shale of that district is from 12 to 20 ft. in thickness, of greenish-grey colour, platy and calcareous, and contains more or less quartz sand and phosphatic material. It rests unconformably on Fernvale limestone, and is in some places overlaid by the St. Clair limestone. The Cason shale forms part of the Richmond group, which is placed in the Ordovician system by the U.S. Geol. Survey, and in the Silurian system by Ulrich. The Wabana iron ore is of the former age.

At the Cason mine, Arkansas, the shale, according to Hugh D. Miser, consists of red "buttons," succeeded in depth by those of the same colour, but having rims of

black manganese oxide, and, finally, by black "buttons" of manganese oxide. These so-called "buttons" are flattened, concretion-like masses from ½ in. to 1 in. in their longer diameter, and from ¼ in. to ½ in. in thickness, and are stated by E. O. Ulrich to be fossil algæ belonging to the genus *Girvanella*. They were once spherical, or nearly so, and were composed mainly of calcium carbonate and partly of manganese carbonate, but they have been flattened by pressure. Their most noteworthy occurrence is at the Cason mine, which has been the largest producer of low-grade ferruginous manganese ore in the district, and the buttons of manganese oxides are so numerous that the residual clay itself has been mined and shipped without any treatment, and much of the shale has been quarried as ore (" Preliminary Report on the Deposits of Manganese Ore in the Batesville District, Arkansas," *Bull.* 715 G, *U.S. Geol. Survey*, p. 102).

Mercury

New Zealand.—A description of the cinnabar deposits of Puhipuhi, situated ninety-five miles north of Auckland, New Zealand, which are now being worked, is given in the *Chem. Eng. and Min. Rev.* (Mar. 5, 1921, p. 205). The basement rocks are andesitic (Tertiary); resting upon them are limestones, quartzite, shales and chert, capped by doleritic and basaltic flows. The cinnabar is disseminated through the fractured chert for an unknown distance from the hanging-wall of the deposit, on which is a band, 12 in. in thickness, of hard oxidised iron minerals. The richest ore is adjacent to the hanging-wall, and is mixed with ferric oxide from the latter. Its average content is 10 per cent., while over a sloping width of 78 in. the average is 2 per cent. of mercury. There is no visible foot-wall. The ore is very wet, and the richer portion is in a fine state of division. Treatment tests have been made with the Thornhill wet process, in which sodium sulphide is the solvent and aluminium the precipitant. The results were satisfactory, and further tests are being made. Ore to the value of £30,000 is said to have been opened up already. Up to the present, 395 flasks, or upwards of 13 tons of mercury have been produced and sold for £8,000.

Molybdenum

Canada.—In the *Summary Rept. of the Geol. Survey of Canada for* 1919, Part E, M. E. Wilson describes the molybdenite deposits of the Renfrew-Calabogie district of the Ottawa Valley, Ontario. These deposits are associated with granite and other igneous rocks of the granite type, either

within the granitic body itself or along the contact of this body with crystalline limestones. The principal mine is situated three miles from the village of Mount St. Patrick and twenty miles S.W. of the town of Renfrew. Production commenced in 1915 and continued until 1918, and a plant to dress 25 tons of ore per day has been erected. The ore-body consists of molybdenite-bearing pyroxenite, and is found on the contact of pegmatite and limestone. The Spain mine, thirty miles S.W. of Renfrew and eight miles S.W. of the village of Dacre, was discovered in 1912 and started to produce ore in 1915. The ore-body consists of small veins of molybdenite, intersecting pegmatite and aplite dykes, and also monzonite-gneiss into which the dykes have intruded. The molybdenum veins cannot be mined without removing the intervening country rock, the grade of the mixed material being in the neighbourhood of 1 per cent. of molybdenite.

Norway.—The *Iron and Coal Trades Rev.*, April 1, 1921, contains an abstract of an address by Otto Falkenberg to the Norwegian Polytechnic Society on the subject of the molybdenum industry of Norway. The ores of molybdenum found in Norway are obtained from Mandal, Stavanger, and Nordland counties, and consist of molybdenite. Mining commenced in 1913 with the opening of the Kvina mine, and in the following year the Knaben mines were opened. During the war Germany purchased the molybdenum output of Norway until 1917, when a contract was made with the British Government. At the end of the war over thirty separate mines were being operated, but the subsequent decline in prices has resulted in more than half of them being closed. The production of molybdenum to date is estimated at about 800 tons, and there is reason to think that Norway could supply 150 to 200 tons per annum if satisfactory prices were obtainable.

Monazite

India.—According to H. C. Jones (*Rec. Geol. Survey, India*, 1921, **51**, 156) monazite has been found in a stream-bed near the village of Wan Hapalam in Mong Kung State, one of the Southern Shan States of Burma. The quantity of sand is small and unlikely to be of economic importance.

Nickel

Union of South Africa.—The *S. Afr. Min. and Engin. Journ.*, Feb. 19, 1921, p. 675, contains an article pointing out that a company has been formed to develop a property near Barberton on which a deposit of nickel ore has recently

been discovered. According to the reports of V. Grindley Ferris (mining engineer) and Major Trevor, A.R.S.M. (Inspector of Mines, Pretoria), the ore occurs in lenticular masses in shales and phyllites and crops out on the shoulder of a hill on "Bon Accord" Farm. Mineralogically the deposit is probably genthite (= garnierite), a hydrated silicate of nickel and magnesium, associated with magnetite. Numerous analyses have been made giving varying percentages of nickel, the highest being 25·8 per cent. It is not proposed to smelt the ore, but to export it to Europe.

Phosphates

India.—A description of the apatite-magnetite deposits of Dhalbhum, India, by E. F. O. Murray, appears in the *Mining Mag.*, April 1921, p. 211. The district is about 120 miles due west of Calcutta and has an area of 1,100 square miles about equally divided into cultivated land and jungle. Hills up to 2,000 ft. are numerous and usually covered with sal forest, scrub jungle and thorn bushes. The district is drained by the Subarnarekha River and traversed by the main line of the Bengal–Nagpur Railway. Economic minerals and rocks produced include chalcopyrite, apatite, magnetite, hæmatite, auriferous quartz, wolframite, white quartz, pot-stones, a loose-grained quartzite used as a building stone, kankar and tufa, limestone, diorite, and granite. The greater portion of the pergannah of Dhalbhum is occupied by the Dharwar series of metamorphosed sediment of Archæan age, represented chiefly by talc and mica schists, quartzites, phyllites and argillaceous slates, striking N.W. and S.E. and dipping usually to the north. Parallel to the foliation of these schists, etc., a series of basic rocks has been intruded as sills and laccoliths, sometimes grading laterally into hornblende schists. These intrusions occur chiefly in the northern border district and to the west, and, though later than the Dharwar series, are also of Pre-Cambrian age. The southern portion of the district is occupied by a mass of gneiss of still later date, which is again pierced by acid and basic dykes. The apatite-magnetite deposit is probably connected with the earliest acid intrusions. Apatite was first noticed in 1907 near Patholgora, where the apatite-magnetite ore was being worked for iron, but it was not until 1915 that its economic importance was recognised. Subsequent prospecting has shown the existence of the ore along a line from Patholgora S.E. to Bagjanta (7 miles), and then, owing to a fault, from Gaura to Kedjurdari (7 miles). The most important deposit of apatite is at Sungi, where it occurs in a belt of biotite schist between two beds of quartzite which

form a ridge 2,000 yards long. The main ore-shoot is confined to the central portion of 3,000 ft. length at the surface, and of mean width about 3 ft., and is found as blebs and lenses of various sizes. Secondary changes brought about by hydrothermal action have resulted in the formation of quartz and chalcopyrite, together with small amounts of malachite, azurite, cuprite, native copper, bornite and a uranium mineral of greenish-yellow colour, probably autunite.

The proportions of apatite to magnetite vary greatly, but an average sample gave approximately equal proportions by weight. The apatite, which is of cream colour, resembling felspar, is of high grade, giving about 80 per cent. of tricalcic phosphate, 2 per cent. fluorine, and 10–12 per cent. of insoluble matter; but no complete analysis of the ore has yet been made.

Probably half the magnetite could be separated by hand-picking after crushing, and the rest should be readily removable magnetically or otherwise.

At present, except at Patholgora, the apatite is not worked in spite of the urgent need of India for phosphatic manures and the high cost of imported fertilisers.

Potash

Canada.—*Memoir* 121, *Geol. Survey, Dept. Mines, Canada,* deals with potash in Cumberland County, Nova Scotia. Potash salts have been found in the course of working the Malagash salt deposit. The quantity present varies considerably; thus, in a shaft near the top of the salt bed a 4 ft. seam contained 1·1 per cent. of potash, but in another part of the mine material carrying as much as 8·73 per cent. of potash was found.

France.—A good account of the mode of occurrence and present-day working of the potash deposits of Alsace is given in *Chem. and Met. Engin.* (1921, **24**, 655).

China.—Potassium salts have been found in many brine wells of the Szechwan district, which range in depth from 1,000 to 3,000 ft. After the salt has been recrystallised the residual mother liquor contains about 3½ per cent. of potassium (*U.S. Comm. Repts.*, 1921, No. 37, p. 896).

Eritrea.—An account of potash mining in Eritrea is given in *Fert. and Feeding Stuffs Journ.* (1921, **4**, 285). The deposits are situated 200 ft. below sea level in the Asale salt plains, about ten miles over the Abyssinian boundary. They have been operated since 1915. A motor

road to the Italian boundary connects the deposits with a narrow-gauge railway forty-six miles long, which runs to the port of Mersa Fatimari. The salts as mined contain about 90 per cent. of potassium chloride. The largest output obtained was in 1917, when 3,578 metric tons were exported. It is stated that the deposit could yield 5,000 to 8,000 tons of salts per month.

United States.—The quantity of crude potash salts produced in the United States in 1920 amounted to about 167,346 short tons, containing 48,625 short tons of actual potash (K_2O) (*Amer. Fert.*, April 9, 1921, p. 66). The number of potash plants in operation was sixty-five, as compared with 128 and 77 in 1918 and 1919 respectively. The output during 1920, which was 57 per cent. larger than in 1919, was obtained from the following sources:

	No. of plants.	Crude potash salts. *Short tons.*	Actual potash (K_2O). *Short tons.*
Salines	17	132,110	38,141
Cement dust	7	10,056	1,141
Blast furnace dust	9	1,503	152
Distillery waste	4	9,420	3,253
Sugar refinery waste	7	9,201	3,394
Wood ashes	16	294	200
Alunite, silicate rocks, kelp and other sources	5	4,762	2,344
Total	65	167,346	48,625

A useful account of the size, composition and estimated potash content of the Nebraska brine lakes is given in *Amer. Fert.* (April 23, 1921, p. 43).

Brazil.—According to *Engin. and Min. Journ.* (1921, **111**, 378), potassium nitrate is being produced in quantity from deposits in numerous large caves occurring in the limestone formation of the Chapada.

Sapphires

Australia.—According to a report in *Engin. and Min. Journ.*, April 16, 1921, the Queensland Government have concluded an agreement with a company for the marketing of Queensland sapphires. The firm will advance 75 per cent. of the value of the gems, but the Government will control the scheme and will, in the first place, acquire all sapphires produced in Queensland so as to ensure their sale through the company.

Sulphur

Mesopotamia.—E. H. Pascoe, in *Rec. Geol. Survey, India* (1920, **51**, 153), describes a milky yellow pool twenty-

four miles S.S.E. of Mosul and one and a half miles N. of the confluence of the Tigris and Greater Zab Rivers, at a spot where the former deserts its eastern channel. This channel, fed by a large spring, now holds a sheet of water whose surface appears almost to boil in places owing to the brisk evolution of hydrogen sulphide gas. The odour is intense, and can be smelt some miles away. Occasionally there is an odour of tar as well, and bituminous earth occurs in the bank of the stream. The Tertiary beds beneath are of Fars age. The southern end of the pool is milky yellow owing to oxidation of hydrogen sulphide and separation of sulphur, which, however, is too finely disseminated for it to be collected.

The author suggests the collection of the hydrogen sulphide by a gas-tight dome over the " live " area, for conversion into sulphuric acid, or, alternatively, the conversion of the gas into sulphur by burning it in a limited supply of air, or by passing sulphur dioxide into the stream. The supply of hydrogen sulphide is probably continuous, and has been known to local natives for about 100 years, the locality being called " The Fountain of Hell."

Tin

South-West Africa.—According to the *South African Min. and Engin. Journ.*, April 9, 1921, cassiterite-bearing areas occur on both the east and west flanks of Pankwob Mountain, at Amieb and Erongo, all of which are within reasonable distance of a railway. A leading Rand house is said to have acquired claims in the Pankwob Mountain district, and the other areas referred to are also receiving attention.

Vanadium

Peru.—A description of the vanadiferous asphaltites of Central Peru, by J. G. Baragwanath, appears in *Engin. and Min. Journ.* (1921, **111**, 778). The known occurrences are in four districts in the departments of Junin and Lima and extend from Marcapomacocha to Sillapata. In the Marcapomacocha district the asphaltites yield from 10 to 20 per cent. of ash, which contains about 7 per cent. of vanadic oxide. The deposits of Sillapata occur at a height of 14,000 ft., about 15 miles from the railway station of Matucana. Asphaltite, which occurs in a strip of metamorphosed limestone between two large flows of rhyolitic rocks, cannot be used for domestic fuel, as it breaks fine. The most important deposits are those near Huari where the Chincho mine produces about 300 tons of asphaltite per month. The principal vein varies from 6 in. to 35 ft. in thickness, and strikes N.W. and S.E.

with a nearly vertical dip. The material gives about 2·2 per cent. of ash, of which 1 to 2·5 per cent. is vanadic oxide. The asphaltites of the Yuali districts are not of importance as fuel, but are of interest as they contain up to 1·06 per cent. of vanadic oxide.

NOTICES OF RECENT LITERATURE

THE BASES OF AGRICULTURAL PRACTICE AND ECONOMICS IN THE UNITED PROVINCES, INDIA. By H. Martin Leake, M.A., Sc.D., F.L.S. Pp. viii + 278, Med. 8vo. (Cambridge: W. Heffer & Sons, Ltd., 1921.) Price 15*s.* net.

The title of this valuable and highly original work clearly indicates its scope. It is divided into forty conveniently brief chapters, each of which presumably represents one of the lectures at the Cawnpore Agricultural College on which it is based. The use of such terms as "metabolism" and "plasmolysis" without explanation suggests that the audience must have consisted of fairly advanced students, and Dr. Leake's argument is too condensed and too continuously involved to have rendered it readily comprehensible to any audience. As he is elucidating the practical and economic principles which it is most desirable that everyone concerned in Indian agriculture should grasp, it is, therefore, well that his hearers as well as others should have the opportunity of reading what he has to say. The book appears to be intended mainly for Indian students; but nearly all the vernacular technicalities employed are explained in a glossary; and most of the principles enunciated are applicable to other tropical lands, if not universally. As the author points out (p. 94), most books on agriculture "are based on experience gained in temperate climates . . . countries of moderate rainfall and low temperature, leading to little loss by evaporation; the problem is, consequently, one of removal of excess moisture," *i.e.* drainage, whilst in India the high temperature and rapid evaporation make the conservation of soil-moisture more important. The author's treatment of surface-tension, capillarity, the colloidal adsorption of clay and humus and the formation of "reh" or alkaline efflorescence is most interesting; but his account of the nitrogen cycle and the rôle of soil-bacteria as regards energy is certainly too condensed for the ordinary reader. The great importance of improving the strength of the bullocks, the draught cattle of India, by the general introduction of a green-fodder crop, such as lucerne grown under irrigation, into the rotation, "leading up to stall-

feeding," is another matter of practice closely related to the economic principles which form the main feature of the work. The question whether the provision of manure or of such improvements as wells, or the borrowing of money is or is not economically defensible as ultimately profitable is admirably argued in connection with the law of diminishing return. An appallingly graphic account of the Bengal famine of 1769–70, taken from Hunter's *Annals of Rural Bengal*, is employed to illustrate the fundamental importance of transport to a dense population; the essential differences between India as a thickly peopled land of small cultivators and such a country as Canada, where the widely scattered farmers, producing in bulk, can make economical use of labour-saving appliances, are well brought out; and the whole argument leads up to the recommendation of co-operation for loans, sale of produce, seed supply, dairying and the purchase of engines.

We have noticed a few slips, such as the use of the word "minerals" for "metals" on p. 66, and the absence of "kela" and "desi-plough" from the glossary, while the use of "will" for "shall" is annoying to the English reader; but, though by no means easy reading, the work as a whole is well worth study, especially by agricultural administrators in India; and may well prove usefully suggestive to those in other lands.

COMMERCIAL COMMODITIES. By Frank Matthews, B.Sc., A.I.C., F.C.S. Pp. vi + 319, Med. 8vo. (London: Sir Isaac Pitman & Sons, Ltd., 1921.) Price 12*s*. 6*d*. net.

It seems probable that this well-intentioned book will appeal to a somewhat limited class of readers. In his preface the author states that he does not pretend to instruct the skilled technician in the material used by him, but to give to the student and general reader an idea of the more important raw, or semi-manufactured, articles used in trade. At the outset he very rightly gives definitions of the physical terms used in describing the properties of commodities. This is followed by a brief general description of methods of preservation, and a little more than a page devoted to "the nature of matter." The descriptions of the elementary principles of the chief manufacturing processes throughout the book are well done and well illustrated, so that the junior student of manufacturing chemistry may find it a useful compendium, though the numerous chemical formulæ, graphic and empiric, will frighten the "general reader." The main classification of commodities into mineral products, food-stuffs, and drugs, and those not previously classified, ap-

pears somewhat crude, and there is throughout very little strictly commercial information as to the comparative yield, district of production, or marketing of the various products.

The metallurgical portion of the work appears to us the best, though we very much doubt if quicksilver derived that name from its volatility (p. 23). Whatever else turtle-soup may be made from, it is certainly not made as stated on p. 175, from the shield or shell of the turtle, nor can the green fat be accurately termed a part of the shell.

The vegetable products are less satisfactorily dealt with. The author does not appear to know the difference between a variety and a species: most of the generic names are printed with small initial letters, and a great number of them are misspelt, whilst in many cases the names of the plants from which products are obtained are not given. Thus millet is said (p. 143) to be "one of the cereal grasses," Sorghum to be "a special variety of millet," tea (p. 176) to be "*thea chinensis* and *thea sinensis*, and various hybrids"; the various species of *Coffea* are not named; there is no mention of cutch or mangrove-bark among tanning materials; and, though there is a fairly detailed account of paper-pulp, it is nowhere explained that spruces are by far the most important woods employed in its manufacture. It is misleading to speak of jute both as derived from *Corchorus* (misspelt *Corcorus*) and as grown in China, Formosa and Malaysia, as well as in Bengal. A considerable space is devoted to synthetic drugs and dyes, and there is a good chapter on manures, in which, however, there is no mention of either apatite or phosphate-rock. The trade in fresh fruits and in tinned fruits, meat and fish is very briefly treated; essential oils are barely mentioned; nor do we find any reference to casein and its derivatives. At the same time, after careful revision, the volume may prove of considerable use to the class of students we have mentioned.

THE BANANA: ITS CULTIVATION, DISTRIBUTION AND COMMERCIAL USES. By William Fawcett, B.Sc. (Lond.). With an Introduction by Sir Daniel Morris, K.C.M.G., D.Sc., D.C.L., F.L.S. Second and enlarged edition. Pp. xi + 299, Demy 8vo. (London: Duckworth & Co., 1921.) Price 15*s*. net.

Since its first appearance in 1913 (cf. this BULLETIN, 1914, **12**, 166), this work has become universally recognised as the standard book on the banana, and its reissue on the exhaustion of the first edition was a matter of course. The present issue only differs from the previous one in

the addition of twelve pages in the Appendix which give the history and discuss the cause and control of the very serious Panama disease or Banana wilt (*Fusarium cubense*), which has played such havoc in plantations in the West Indies in late years. Mr. Fawcett concludes that the only solution of the problem presented by this disease is by the propagation of individually selected resistant strains. This has been successfully started in Porto Rico.

THE SWEET POTATO: A Handbook for the Practical Grower. By T. E. Hand and K. L. Cockerham. Pp xi + 261, Crown 8vo. (New York: The Macmillan Co., 1921.) Price 16*s*. net.

This addition to the "Rural Science Series" of handbooks deals with the sweet potato crop from the point of view of the cultivator in the United States. Although met with chiefly as a native food crop throughout tropical countries, the sweet potato has of recent years become of considerable commercial importance in certain areas of the United States, where it now ranks second only to the white or Irish potato as a vegetable. Its commercial production is confined for the most part to the South Atlantic and Gulf Coast States, the largest acreages being in Alabama and Georgia. The value of the crop in the United States for the year 1918 was estimated at nearly 117 million dollars. It is exceedingly sensitive to frost, and is essentially a hot-weather crop requiring about four and a half months to reach normal maturity.

As a food, the sweet potato has a fuel value in calories equal to about one and a half times that of the white potato. It is used chiefly as a human food, but may also be utilised for starch and alcohol manufacture, and as a food material for domestic animals. The handbook gives a detailed account of the methods of propagation, which are chiefly by sets from the tubers (called "seed"), or by cuttings from the growing stems; the importance of selecting healthy stock with a view to the prevention of diseases and to securing a smooth, medium-sized, spindle-shaped potato is emphasised. The tillage operations and appliances, the most suitable manures, and the place of the crop in systems of rotation are also fully discussed. The sweet potato is said to be subject to mutation, or "sporting," and many new varieties have originated in this way which differ from each other mainly in the length of the vine or stem, the shape of the leaves, the texture and colour of the flesh, and the colour of the skin. Upwards of fifty varieties are described in the handbook, but only about a dozen are said to be of importance from

the market standpoint. Two chapters of the handbook are devoted to the insect and fungoid diseases that attack the sweet-potato crop, and the necessary remedial and control measures are described ; in the concluding chapters the harvesting and storage of the crop are dealt with, and also methods adopted in preparing the roots for market and for their subsequent commercial disposal.

The importance of increasing the food supply in tropical countries, in order that cheap labour may continue to be available, is evident, and in this connection it would seem advisable to give more attention to the sweet potato in countries where it is still only a native crop. This handbook, having been written from a practical standpoint, should prove of much value to those cultivators who propose adopting modern methods for the production of this crop.

THE DISEASES AND PESTS OF THE RUBBER TREE. By T. Petch, B.A., B.Sc. Pp. x + 278, Med. 8vo. (London: Macmillan & Co., Ltd., 1921.) Price 20s. net.

In 1911 Mr. Petch, then, as now, mycologist to the Ceylon Government, published a volume entitled *The Physiology and Diseases of Hevea brasiliensis*, which was reviewed in this BULLETIN (1911, **9**, 433). No work, in our opinion, has ever exhibited a more thoroughly accurate acquaintance with the scientific principles of anatomy and physiology and their application to the practical treatment of *Hevea* in health and in disease, and Mr. Petch became recognised as a court of final appeal on all questions of rubber disease. When this book went out of print the growing army of rubber cultivators naturally required a reissue ; but, as the author says in the preface to the present work, " the number of known diseases of *Hevea* has, unfortunately, been considerably extended during the last eight years." He has, therefore, thought fit to divide his work into two, and has revised the part dealing with diseases for first publication. Following in the main the arrangement of the previous edition, he has, in addition to a thorough revision and enlargement throughout the chapters on the diseases, added one on insect and animal pests, another on sprays and dressings, and a full bibliography. In addition also to the one excellent coloured plate of *Fomes lignosus* that served as frontispiece to the earlier work, we are now given four other admirable plates of fungoid diseases and one of the pests of *Hevea*, the former of which are especially fine examples of natural history draughtsmanship and colour-printing. It is needless to say that this latest authoritative description of the

diseases and pests of *Hevea* will be indispensable for every planter; but we sincerely trust that the "future date," to which the author postpones the reissue of the first half of the original volume, dealing with the physiology of *Hevea*, will not be a distant one. The thorough comprehension of the structure of the bark, its physiology when in health, and the meaning of the results of tapping experiments, is as essential to the successful prosecution of the art of rubber-growing as is that of disease.

RUBBER PLANTING: A BOOK FOR THE PROSPECTIVE ESTATE ASSISTANT IN BRITISH MALAYA. By C. Ward-Jackson. With a foreword by A. B. Milne, and a new Map of British Malaya. Pp. iv + 63, Demy 8vo. (Kuala Lumpur: The Incorporated Society of Planters, 1920.) Price 3*s.* 6*d.* post free.

This invaluable little handbook is an official publication of the Incorporated Society of Planters. In scope it is in no sense a textbook on Para rubber or on the technicalities of planting, but merely a collection of the soundest and most practical advice to any ex-officer or other young man who contemplates taking employment on a Malayan plantation. The proper contract and salary he should receive, the nature of his work, the preliminary training he should obtain, the proper outfit, equipment, and medicines to take out with him, and the money and weights and measures used in the Malay States, are all plainly stated for the would-be planter's assistant. The course of training most directly organised for men intending to occupy such positions seems to be that of the North of Scotland College of Agriculture, Aberdeen, which is all comprised within six months at fees not exceeding ten guineas. While wisely pointing out that rubber planting is not "an easy job, with plenty of time for polo and shooting," this brochure certainly gives the best of advice as to entering what it terms "a far from uninteresting profession." The map of Malaya, on a scale of twenty miles to an inch, is excellent. The book may be obtained from the Home Agent of the Incorporated Society of Planters, Mr. Charles Watney, Courtfield House, Courtfield Road, South Kensington.

CHEMISTRY OF PULP AND PAPER MAKING. By Edwin Sutermeister, S.B. Pp. vii + 479, Demy 8vo. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1920.) Price 36*s.* net.

This work deals with the chemical aspects of the pulp and paper industries. It is intended for the use of the

technical chemist and chemical engineer, and therefore assumes that the reader possesses a general knowledge of chemistry.

A general account is given of the chemistry of cellulose and its compounds. This is followed by a description of the characters and composition of the more important of the fibrous raw materials of paper-making, including the various woods, rags, esparto, straw, bamboo, bagasse, and maize-stalks. This section is illustrated by twenty-six plates, which are reproductions of photomicrographs prepared by the Paper Section of the U.S. Bureau of Standards, showing the characteristic forms and markings of a number of typical paper-making fibres.

In subsequent chapters descriptions are given of the methods of treating rags, of preparing pulp from esparto, straw, bamboo, and old paper, of the manufacture of chemical wood-pulp by the soda, sulphate and sulphite methods, and of the preparation of ground wood or mechanical wood-pulp. The methods of bleaching pulp are also fully described.

A further section of the book is devoted to the chemical problems connected with paper-making, including sizing and sizing materials, loading and filling materials, colours and pigments, and the manufacture of coated papers. Reference is also made to the importance of the water supply to the paper-maker, and the methods of sampling and analysing it are described.

The methods of testing wood pulps and papers, both physically and chemically, are fully detailed, and, in the final chapter, allusion is made to the relation of the paper to the various requirements of the printer and lithographer.

A series of useful tables is appended and a good index is provided.

The volume is well and clearly written and is illustrated by numerous plates and diagrams. It can be recommended as a useful textbook to the paper-mill chemist and the student of paper-making, and will doubtless prove helpful and instructive to all who are interested in the pulp and paper industries.

MODERN PULP AND PAPER MAKING. By G. S. Witham, Sr. Pp. iv + 599, Med. 8vo. (New York: Chemical Catalog Co., Inc., 1920.) Price $6.50, post free.

This treatise has been written with the object of giving practical information to workers in pulp and paper mills. The various processes and the plant employed for carrying them out, particularly in the United States, are fully described with the aid of numerous clear and well-printed

illustrations and diagrams. A noteworthy feature of the book is the paucity of information relating to the chemistry of the processes, the author having endeavoured to explain the subject in such a way as to render it intelligible to those possessing little or no chemical knowledge. This seems to us to detract somewhat from the usefulness of the book, as no paper-maker can conduct his business intelligently and efficiently in the absence of such knowledge.

The manufacture of mechanical and chemical wood-pulps and the various processes involved in paper-making are dealt with in considerable detail, special consideration being given to the different machines employed. Short chapters are devoted to the testing of paper and paper materials, and the causes of paper defects and the methods of overcoming them, and the organisation, personnel and administration of pulp and paper mills are thoroughly discussed. An account is given of trade customs, useful data are supplied relating to various classes of pulp and paper and the cost of production, etc., and a good index is provided.

The work will doubtless be of great service to the practical paper-maker, and will also be of interest to others connected with the pulp and paper industries.

The Practice of Sylviculture, with Particular Reference to its Application in the United States. By Ralph C. Hawley. Pp. xi + 352, Demy 8vo. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1921.) Price 22s. net.

American foresters are rapidly supplying themselves with admirable textbooks adapted to their own local circumstances. This volume, the first American work on its precise subject, deals with forest management during the periods of establishment or regeneration and of intermediate cuttings, and with the protection of the forest against fire, insects and other animals, fungoid disease and climatic injuries. A select bibliography is added to each chapter, and the useful glossary of forest terminology drawn up by a committee is reprinted from the *Journal of Forestry* for 1917 as an appendix. In this many German and French synonyms are given. It is, we think, a mistake, even from a purely American standpoint, not to add the scientific names of those of the trees, especially the pines, to which reference is made. A small initial letter to a generic name occasionally appears, and on p. 278 *Cronartium ribicola* appears as *cronartium Ribicola*; whilst the unspaced writing of such compound words as "unevenaged"

has a puzzling appearance. The work as a whole seems fully adequate to its purpose.

STUDIES IN FRENCH FORESTRY. By Theodore S. Woolsey, Jr., with two chapters by William B. Greeley. Pp. xxv + 550, Med. 8vo. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1920.) Price 36s. net.

It is most desirable that those who are responsible for the management of extensive forests in temperate latitudes, whether in Europe, America or New Zealand, should be put in possession of full particulars as to the excellent methods long practised in France. As Colonel Greeley writes in this work (p. 358): "Probably never in the history of the world has the forest policy of a nation been so clearly vindicated as was that of France by the war of 1914. Wood was one of the most vital military necessities, and the allied armies drew the great bulk of their supplies from the forests of France. . . . For the forest barriers in Northern France, and for the abundant supplies of timber available to the battle lines, the allied world must thank the patience and foresight with which the French nation has built up its forest resources. France could have kept on supplying the vast armies on her soil for one or two years more, if need be, without cutting seriously into her forest capital."

Even before the war France had to import much timber and recognised that her area under forest (18·7 per cent.) was insufficient; but German critics were forced to admit that natural regeneration is more successful there than in Germany, because of the mild climate, sufficient rainfall, and prolific seeding. The French administration recognises the present necessity of restocking considerable areas artificially.

The author of the present volume has borrowed much of his matter from authoritative French sources, a third of the book being occupied by appendixes consisting of translations and abridgements of valuable essays by various writers: Colonel Greeley's two chapters on Impressions of French Forestry and The American Forest Engineers in France are among the most interesting in the volume; and most of the others have been revised by leading authorities. The chapter on Forestry in the Landes gives a full and valuable account of the management of the turpentine industry: one of the appendixes consists of a full discussion by French authors of the sylvics of twelve leading species; a useful table of equivalents for French units of measurement is given in the Introduction; and

the Government policy for control of erosion in the mountains, and their general working plans are described in detail. Mr. Woolsey has, in fact, set forth a very complete exposition of a system, which has been long and successfully carried out, for the benefit of those engaged in establishing new systems under somewhat similar conditions.

Application of Dyestuffs to Textiles, Paper, Leather and Other Materials. By J. Merritt Matthews, Ph.D. Pp. xvi + 768, Demy 8vo. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1920.) Price 57s. 6d. net.

This volume is primarily a textbook for those commencing the study of this subject, and is the result of a comprehensive revision and extension of the author's earlier book, entitled *Laboratory Manual of Dyeing and Textile Chemistry.* An attempt has been made to broaden the scope of the work so as to make it appeal to all those concerned in the application of dyestuffs; but, as the ground covered is so wide it is not surprising that the volume, though excellent for students, is not sufficiently detailed to appeal to the works' chemist or the technical dyer.

The book opens with a brief history of the chief dyestuffs and an account of the equipment required for dye testing, of the forms in which textiles are dyed, and of the chemical characteristics of the fibres. From this the work passes to scouring and bleaching processes, and subsequently introduces the subject proper with a chapter on the classification of dyes, the action of the dyes on the various fibres, and the use of mordants. The succeeding chapters are devoted to the methods of applying dyes to the principal fibres. One chapter deals with the use of logwood, while twelve minor natural dyes are more briefly treated in the chapter that follows. The final chapters are concerned with the minor fibres, the theory of dyeing, the chemical reactions and testing of dyestuffs and colours, the analysis of textile fabrics, and the application of dyestuffs to leather, paper, hair, celluloid, etc. The volume concludes with fifteen pages of useful data for dyers and textile chemists, and eighteen pages of bibliography of the literature of dyeing, bleaching and textile chemistry. A striking feature of the book is the large number of illustrations and diagrams it contains. These are well produced, and represent for the most part plant and machinery used on a technical scale, but their value is unfortunately lessened by the fact that they are not explained or even referred

to in the text. At the end of each chapter a number of experiments are described which are designed to demonstrate to the student the principal points dealt with, thus rendering the volume a valuable laboratory guide for both teacher and student.

LUBRICATING AND ALLIED OILS. By E. A. Evans, F.C.S., A.M.I.P.T. Pp. xiv + 128, Med. 8vo. (London: Chapman & Hall, Ltd., 1921.) Price 9*s.* 6*d.* net.

The author states in the preface that this book has been written "in order to assist chemists in compiling specifications and examining lubricating oils, also to give engineers an insight into the application and properties of such oils and the interpretation of their specifications," and with these objects in view highly technical and controversial matter has been avoided.

The history of petroleum, oil refining and the occurrence of the fatty oils are dealt with in a very cursory manner in the first three chapters, which comprise only ten pages in all. No details are given regarding the methods of preparing lubricating oils for the market; a brief account of the more important processes might well have been included.

The physical and chemical tests to which lubricating oils may be submitted are adequately discussed and much information is given concerning the best methods for carrying out such tests.

The question of the selection of lubricants is dealt with chiefly in relation to the figures obtained as a result of the physical and chemical tests, and a brief account is given of the lubricating oils employed for certain specific purposes.

MINERALOGY: AN INTRODUCTION TO THE STUDY OF MINERALS AND CRYSTALS. By E. H. Kraus and W. F. Hunt. Pp. xiv + 561, Med. 8vo. (New York and London: McGraw-Hill Book Co., Ltd., 1920.) Price 27*s.* net.

In this book, prepared especially for the use of American students, the authors have set out to present the subject to the beginner "in a direct and simple manner," and, we are told in the short preface, "an attempt has been made to vitalise the subject as much as possible."

Following a short introduction, in which the importance of mineralogy in modern civilisation is discussed, the book commences with eight chapters on crystallography, copiously illustrated with photographic reproductions of crystal models, and with clear diagrams. The next five chapters deal shortly with physical and chemical properties, and include descriptions of qualitative blowpipe methods,

the petrological microscope, and notes on the formation and occurrence of minerals. Then follows one long chapter of descriptive mineralogy, in which the usual chemical classification is employed; this is fully illustrated with original photographs of hand-specimens of minerals taken from the collections in the University of Michigan. Next comes a chapter on gems and precious stones, with photographs of diamond cutters and polishers at work; and the final chapter contains a list of minerals classified according to elements, giving the uses and production of the more economically important, together with some statistics. The last 200 pages of the book are occupied by a glossary of the terms used in it, a "tabular classification showing elements of symmetry and the simple forms of the thirty-two classes of crystals," tables for the determination of the 150 minerals described in the text, and a comprehensive index.

The general balance of the work is impaired by lengthy descriptions of the crystal systems, and an exceedingly short review of optical and other physical properties of minerals. Both in the descriptive mineralogy and in the determinative tables optical properties are ignored.

The work contains a large number of photographic and other illustrations, including portraits of eminent mineralogists, and short notes of their work. Many of the photographic reproductions of minerals are very poor, and can only confuse the student.

On the whole, the book is readable and easily intelligible to a beginner.

THE TIN RESOURCES OF THE BRITISH EMPIRE. By N. M. Penzer, M.A., F.R.G.S., F.R.A.S., F.G.S. Pp. x + 358, Demy 8vo. (London: William Rider and Son, Ltd., 1921.) Price 15*s*. net.

This is the second book of a series dealing with the raw materials of industry. The present volume is confined to the tin resources of the British Empire; a second volume is contemplated which will comprise the tin production of countries outside the Empire. The author is indebted to several well-known geologists for certain portions of the text, but the work has, on the whole, been compiled from many sources.

After a brief historical sketch, the stanniferous ores and minerals are described in some detail. The description of several very rare minerals might well have been left out in a work which is written on popular lines. For instance, we are told that the occurrence of stokesite "is at present confined to a single specimen at the Cambridge

Museum." In the chapter devoted to the British Isles, the order of the arrival of the minerals in the lodes of Cornwall is given according to D. A. Macalister (*Economic Geology*, 1908, p. 374), and differs considerably from the time-order of deposition given by Prof. Cronshaw for the lodes of the Camborne district (G. M. Davies, *Tin Ores, Imperial Institute Monograph*, 1919, p. 25). The pneumatolytic theory of the origin of tin and associated metals is referred to as if there were no other in the field, whereas, as a matter of fact, that particular theory has, in recent years, been severely criticised, and, from recent studies, the belief that tin, tungsten and associated metals were deposited by hydrothermal action is gaining ground. Brief descriptions of the principal mines of Cornwall and Devon are followed by tables of output of "black tin," and imports and exports of ore, metal, etc. Some of these tables are from official sources, while six of them are taken from the Imperial Institute Monograph on *Tin Ores*. Altogether twenty tables have been inserted from this monograph, as well as portions of the text.

There are some errors in the book that need revision, *e.g.* "Upper Waterberg *edge*" (p. 191) should be "Upper Waterberg *age*," and on page 151, "the specimen of niriella," should be "the specimen from Niriella," the latter being the name of a place in Ceylon, and not a rock or mineral, as the text would seem to imply. In the quotation from the Monograph on Tin Ores at the top of page 192, relating to the Transvaal, one class of deposits, viz. "irregular dissemination in slightly altered granite," has been omitted.

There is a short chapter on the industrial application of tin, and another on prices, sale of tin and world's output, and a fairly complete bibliography of forty-five pages.

POWDERED COAL AS A FUEL. By C. F. Herington. 2nd edition. Pp. xii + 338, Med. 8vo. (London: Constable & Co., Ltd., 1920.) Price 30*s*. net.

The first edition of this work by an American author was published in 1918 (cf. this BULLETIN, 1919, **17**, 139), and the fact that a second edition was needed in 1920 is an indication of the interest now being taken in the subject of powdered coal as a fuel. The issue of this new edition giving the latest information on the subject is particularly timely when economy in the use of fuel is so necessary.

In the short period that has elapsed between the issue of the two editions great developments have taken place in the utilisation of powdered coal as a fuel, not only in the United States, but also in Europe and Japan. The

author, therefore, whilst leaving the original matter practically as it stood, has added over 120 pages, which deal mainly with the recent use of the fuel in metallurgical furnaces and in boilers. Tables of constants and other useful data are now included, as well as hints on methods of operating a pulverised-coal plant. The bibliography, which in the first edition only went up to 1913, has been extended so as to include articles appearing in periodical publications in 1920. Fifty illustrations have been added, but, through an oversight apparently, the title-page gives the number appearing in the first edition (84).

The Oil Shale Industry. By Victor Clifton Alderson, Sc.D. Pp. ix + 175, Demy 8vo. (New York: Frederick A. Stokes Company, 1920.) Price 26s. net.

The oil shale industry in the United States is new, but will probably be rapidly developed, because it is generally recognised that the crude oil situation of the United States has become precarious. The production of crude petroleum in the United States in 1920 amounted to upwards of 440 million barrels, but even this enormous output fell far short of the consumption. The American production of crude petroleum is believed to have reached its maximum, and, henceforth, a rapid decline is anticipated. In its vast deposits of oil shale lie the potential elements of the future supply of oil in the United States.

In the work under review brief but clear descriptions are given of the principal deposits of oil shale in the United States, and the main differences between them and those of Scotland are pointed out. The rather bald statement on page 17, comparing the former production of the Scottish shale with that of to-day, might lead to a misapprehension. Torbanite, which was formerly worked, and which gave a high yield of oil, may be regarded as a variety of cannel coal and not an oil shale proper. The reason that the average yield of oil from the shale has dropped so much in recent years is largely due to the fact that lower-grade material is now being utilised, the great improvements that have taken place in the method of distillation enabling such material to be mined and treated at a profit.

The distribution of oil shale forms part of Chapter II. In describing the shales of Pictou County, Nova Scotia, Canada, the important oil shale deposits, occurring in a basin east of the East River, do not appear to be alluded to, whilst the Utrecht district of Natal, the most important oil shale field of the Union of South Africa, is also not mentioned.

The history of the oil shale industry is reviewed, a

paragraph referring to the work done at Elko, Nevada, being of great interest. The brief chapter on mining should be read in conjunction with the remarks on page 136 with regard to Scotch and American methods of mining. Other chapters deal with retorting and reduction, experimental and research work, and economic factors, and the whole concludes with a short chapter devoted to the future of the industry, and a bibliography.

The book is well illustrated from photographs of American shale deposits, those showing paper shale (Colorado) and massive shale and oil shale cliff (Utah) being particularly clear. The work can be recommended as forming a useful introduction to oil shale geology and oil shale treatment. It is well written, and is not overloaded with technicalities and other details.

FIELD METHODS IN PETROLEUM GEOLOGY. By G. H. Cox, Ph.D., E.M., C. L. Dake, M.A., and G. A. Muilenburg, M.A. Pp. xiv + 305, Crown 8vo. (New York and London: McGraw-Hill Book Company, Inc., 1921.) Price 24*s*. net.

The authors state in the preface that this work is intended to fill a gap in the literature of oil geology as regards field procedure, and that it is written for those who are moderately familiar with the fundamental principles of geology, surveying and mathematics, including at least trigonometry. The work fulfils the purpose for which it was written, and will be welcomed by a large number of students—using the term in its widest sense—of a highly specialised branch of engineering geology.

The first chapter treats of the instruments used. Among these, the aneroid barometer and the alidade, and the plane table on which the latter is used are described in considerable detail. Chapter II is on instrument methods. Stadia methods and the determination of elevation by the aneroid are fully discussed and the Beaman stadia arc, gradienter screw, the stadia wire and other methods are explained. The next two chapters dealing respectively with the identification of structure and field operations are eminently practical, and contain suggestions of value.

The book is well and clearly illustrated and concludes with some useful tables and a glossary.

PRINCIPLES OF HUMAN GEOGRAPHY. By Ellsworth Huntington and Sumner W. Cushing. Pp. xiv + 430, Med. 8vo. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1921.) Price 21*s*. net.

This excellent example of American science is designed for students who have begun " to think for themselves " ;

and, while incidentally imparting an immense amount of valuable information on a wide range of topics, such as the principles of meteorology, agriculture, dietetics, and the physical interpretation of history and politics, is most useful as a stimulus to such original thinking. For this reason it will be, perhaps, more valuable to the teacher or the earnest solitary student than as a class-book, though the numerous problems propounded at the close of each chapter are admirably adapted for home work or holiday tasks for senior classes.

Human geography is viewed as consisting of man's relations to the five physical or non-living conditions, location, land forms, bodies of water, soil and minerals, and climate; to vegetation; to animals; and to his fellow-man; together with what are termed the "Human Responses" which are classified under twenty-one heads arranged in four groups, from such "Material Needs" as food, clothing and shelter to "Occupations," of which eight types are enumerated, "Efficiency," including race, health and energy, and recreation, and "Higher Needs," which comprise government, education, science, religion and art. To guard against the obvious criticism that the determining influences of man's material environment have been over-emphasised, it is properly pointed out (p. 21) that geographical surroundings "are only one of the great factors which determine the progress of a nation." There is a pleasing originality about the illustrative examples made use of throughout the book, the descriptions of the Kirghiz nomads, for instance (pp. 12–21), and those of Aleppo and Shantung (pp. 294–297) suggesting knowledge gained at first hand by intelligent travel.

In some instances scientific hypotheses have been too unreservedly converted into dogmatic statements, as in the date assigned to the climax of the Glacial Period on p. 210; and, perhaps, the statement of Suess's theory of earth-movement on p. 51; and a few slight errors in fact or expression occur, as might well be anticipated in so wide a field. It is, for instance, misleading to speak of "tubercles of nitrogen" on the roots of clover (p. 165), or to suggest that gold was ever deposited "as nuggets" from mineralised water. The recent growth of cocoa-production in the Gold Coast has vitiated the summary of the world's production given on p. 287; and at no time was it historically accurate to speak of Portugal as having been driven out of Ceylon by Great Britain (p. 395). These are, however, easily remediable blemishes in what is unquestionably a very valuable work.

BOOKS RECEIVED

The South and East African Year Book and Guide. Edited annually by A. Samler Brown, F.R.M.S., and G. Gordon Brown, F.R.G.S., for the Union-Castle Mail Steamship Company, Limited. 1921 Edition. Pp. liv + 915, Crown 8vo. (London: Sampson Low, Marston & Co., Ltd.). Price 5*s.*

Tanning Materials, with Notes on Tanning Extract Manufacture. By Arthur Harvey. Pp. vii + 182. Demy 8vo. (London: Crosby Lockwood & Son, 1921.) Price 15*s.* net.

Perfumes, Essential Oils, and Fruit Essences used for Soap and other Toilet Articles. By Geoffrey Martin, D.Sc. (Lond. & Bristol), Ph.D., F.I.C. Pp. vii + 138, Royal 8vo. (London: Crosby, Lockwood & Son, 1921.) 12*s.* 6*d.* net.

Insect Pests of Farm, Garden and Orchard. By E. Dwight Sanderson. 2nd ed., revised and enlarged by Leonard Marion Peairs. Pp. vi + 707, Demy 8vo. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1921.) Price 26*s.* net.

Elements of Engineering Geology. By H. Ries, Ph.D., and Thomas L. Watson, Ph.D. Pp. v + 365, Med. 8vo. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1921.) Price 22*s.* net.

Petrographic Methods and Calculations. By Arthur Holmes, D.Sc. (Lond.), A.R.C.S., D.I.C., F.G.S., F.R.G.S. Pp. xix + 515, Med. 8vo. (London: Thomas Murby & Co., 1921.) 31*s.* 6*d.*

Technical Methods of Analysis as employed in the Laboratories of Arthur D. Little, Inc., Cambridge, Mass. Edited by Roger Castle Griffin, Director of Analytical Department. Pp. xv + 666, Foolscap 4to. (New York and London: The McGraw-Hill Book Company, Inc., 1921.) Price 33*s.*

A Textbook of Assaying: for the use of those connected with Mines. By C. and J. J. Beringer, revised by H. R. Beringer. 15th ed., revised. Pp. xvi + 471, Post 8vo. (London: Charles Griffin & Company, Ltd., 1921.) Price 12*s.* 6*d.* net.

Oil Land Development and Valuation. By R. P. McLaughlin. Pp. viii + 196, Crown 8vo. (New York and London: McGraw-Hill Book Company, Inc., 1921.) Price 18*s.* net.

Field Mapping for the Oil Geologist. By C. A. Warner. Pp. x + 145, Foolscap 8vo. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1921.) Price 13*s.* 6*d.*

The Electric Furnace. By J. N. Pring, M.B.E., D.Sc. Pp. xii + 485, Med. 8vo. (London: Longmans, Green & Co., 1921.) Price 32*s.* net.

Highway Engineering: Rural Roads and Pavements. By George R. Chatburn, A.M., C.E. Pp. xii + 379, Demy 8vo. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1921.) Price 18*s.* net.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Dominion, Colonial and Indian Governments.

NIGERIAN GRASSES FOR PAPER MAKING

In the previous number of this Bulletin (1921, **19**, 174) an account was given of a large number of grasses which have been tested as paper-making materials. No West African grasses are referred to in the article, as at the time it was written nothing was known as to their paper-making qualities. Early in the present year, however, two series of dried grasses, belonging in all to ten different species, were received at the Imperial Institute from Nigeria in order that their suitability for the manufacture of paper might be ascertained. An account of their investigation is given in the following pages. The grasses were forwarded under their native names. The botanical names were determined at the Royal Botanic Gardens, Kew, from specimens supplied from the Imperial Institute.

Series I

No. 1. *Ekong* (*Imperata cylindrica*, Beauv.).—This consisted of dried grass, pale straw to brown in colour, 4 to 6 feet in length, and composed of leaves and thin stems, the leaves forming the greater part. Small portions of the hard rhizome had been left at the base of the stems.

No. 2. *Esun* (*Pennisetum* sp.).—This consisted of dried grass composed of stem and leaf in approximately equal quantities. The stems measured about 6 feet in length and from ¼ to ½ inch in diameter, with nodes approximately 6 inches apart.

No. 3. *Eruwa* (*Andropogon tectorum*, Schum.).—This consisted of dried grass including rather more stem than leaf. The stems measured from 5 to 7 feet in length and up to ½ inch in diameter, with nodes at intervals of about 10 inches.

The results of examination of these three grasses were as follows:

No. 1. *Ekong* (*Imperata cylindrica*, Beauv.).—A chemical examination of this grass, as received, gave the following results:

	Per cent.
Moisture	10·1
Cellulose	41·3[1]
Ash	5·2

[1] *Equivalent to 45·9 per cent. in the moisture-free material.*

The ultimate fibres measured from 0·6 to 1·3 mm. in length, being mostly from 0·8 to 1·1 mm.

The grass was submitted to treatment with caustic soda under conditions similar to those used in the manufacture of paper pulp on a commercial scale, with the following results, which are expressed in each case on the grass as received:

Trial.	Caustic soda used.		Conditions of boiling.		Caustic soda consumed per 100 parts of grass.	Yield of dry pulp.
	Parts per 100 parts of grass.	Parts per 100 parts of solution.	Time.	Temp.		
			Hrs.	° C.		*Per cent.*
A	16	4·0	6	150	9·0	37·5
B	20	4·5	8	160	12·0	30·0
C[1]	16	3·5	3·5	150	8·5	41·0

[1] *In Trial C the pieces of hard rhizome were removed from the stems.*

The pulp obtained in Trial A, *i.e.* on treatment with 16 parts of caustic soda per 100 parts of grass, could not be completely disintegrated in the beater, but it was found possible to bleach it to a pale cream colour. Treatment with 20 parts of caustic soda (Trial B) yielded a better pulp, which, however, did not break up completely and produced paper of only fair strength.

In Trial C, in which the pieces of hard rhizome were removed from the stems and only 16 parts of caustic soda

were used, a better yield of pulp was obtained, which broke up well in the beater and bleached to a cream-white tint, producing a strong paper of good quality.

It is evident from these results that the refractory part of the material consists of the hard rhizomes and that if care is taken to exclude these in collecting the grass, a fair yield of pulp of good quality will be obtainable.

No. 2. *Esun* (*Pennisetum* sp.).—A chemical examination of this grass, as received, gave the following results :

	Per cent.
Moisture	10·1
Cellulose	41·6[1]
Ash	7·3

[1] *Equivalent to* 46·2 *per cent. in the moisture-free material.*

The ultimate fibres measured from 0·8 to 2·2 mm. in length, being mostly from 1·0 to 1·9 mm.

On treatment with caustic soda the grass furnished the following results, which are expressed in each case on the material as received :

Trial.	Caustic soda used.		Conditions of boiling.		Caustic soda consumed per 100 parts of grass.	Yield of dry pulp.
	Parts per 100 parts of grass.	Parts per 100 parts of solution.	Time.	Temp.		
			Hrs.	° C.		*Per cent.*
A	16	4	8	160	10·2	35
B	20	4·5	8	160	12·1	33·7

The pulp produced in Trial A by treatment with 16 parts of caustic soda per 100 parts of grass could not be broken up in the beater, and only bleached to a deep cream tint. Under the more drastic conditions of Trial B the grass furnished a pulp which broke up fairly well, bleached to a fairly satisfactory cream colour, and felted well, producing a paper of good strength. The yield, however, was rather low.

No. 3. *Eruwa* (*Andropogon tectorum*, Schum.).—A chemical examination of this grass, as received, gave the following results :

	Per cent.
Moisture	10·8
Cellulose	44·2[1]
Ash	4·2

[1] *Equivalent to* 49·5 *per cent. in the moisture-free material.*

The ultimate fibres measured from 0·6 to 1·5 mm. in length, being mostly from 0·9 to 1·2 mm.

On treatment with caustic soda the grass furnished the following results, which are expressed on the grass as received :

Trial.	Caustic soda used.		Conditions of boiling.		Caustic soda consumed per 100 parts of grass.	Yield of dry pulp.
	Parts per 100 parts of grass.	Parts per 100 parts of solution.	Time.	Temp.		
			Hrs.	°C.		*Per cent.*
A	20	4·5	9	160	12·4	42·0

The pulp obtained under these conditions was broken up almost completely in the beater and the operation was completed during the bleaching process. The pulp bleached to a pale cream colour, and yielded a paper of fairly good strength.

These three grasses could all be used for the manufacture of paper pulp on a commercial scale. It would probably not be remunerative to export them from Nigeria, but they could be employed for the manufacture in the Colony of "half-stuff," which should be readily saleable in the United Kingdom for the manufacture of high-grade wrapping papers of brown or cream colour.

If the grasses were used in a fresher condition than the present samples, it is probable that less caustic soda would be required and that the resulting pulp could be more satisfactorily bleached.

In the collection of these grasses on a commercial scale care should be taken to exclude all portions of the hard rhizomes in order that they may not cause difficulty in the treatment of the grass, as in the case of the present Sample No. 1.

Series II

This comprised eight grasses which were stated to occur in large quantities in the Northern Provinces, Nigeria. The material consisted in all cases of grass stems, cut into lengths of from 2 to 2½ feet.

No. 1. *Jinfi* (*Andropogon Gayanus,* Kunth.).—The

stems of this grass were of a pale yellow to yellowish-green tint. They measured up to $\frac{7}{16}$ inch in diameter and bore nodes at intervals of from 6 to 18 inches.

No. 2. *Gamba* (*A. Gayanus*, Kunth.).—These stems had a diameter up to $\frac{5}{16}$ inch, and were similar in general appearance to No. 1.

No. 3. *Sasari* (*Chasmopodium Afzelii*, Stapf, *vel* sp. nov.).—The stems in this case measured up to $\frac{5}{16}$ inch in diameter. The grass was somewhat similar in general appearance to No. 1 (Jinfi), but was of a paler tint.

No. 4. *Tsauri* (*Cymbopogon giganteus*, Chiov.).—This was a straw-coloured grass up to $\frac{1}{4}$ inch in diameter. It was somewhat similar in general appearance to Nos. 1, 2, and 3, but it bore small flowering heads possessing a characteristic aromatic odour.

No. 5. *Yama* (*Hyparrhenia rufa*, Stapf).—This was also straw-coloured, with a diameter up to $\frac{1}{4}$ inch. The stems bore pale reddish-brown leaves and flowering heads.

No. 6. *Kitsi Gujma* (*H. rufa*, Stapf).—This grass was of similar appearance to No. 5 (Yama), but the stems were rather thinner.

No. 7. *Baya Maria* (a mixture of *Andropogon Gayanus*, Kunth., *Hyparrhenia subplumosa*, Stapf, and *Trichopterix* sp.).—These stems were of a dark straw colour and measured up to $\frac{1}{8}$ inch in diameter. The material was similar in general appearance to No. 5 (Yama).

No. 8. *Wuchiyan Bera* (*Ctenium elegans*, Kunth.).—These stems had a diameter up to $\frac{1}{8}$ inch. The grass was of a pale straw tint and distinguished from the other seven samples by the presence of characteristic, feather-like flowering heads about 9 inches in length and $\frac{1}{4}$ inch wide.

In each case the grass was submitted to the action of caustic soda under conditions similar to those employed commercially for the production of paper pulp, and the results given in the succeeding paragraphs are expressed on the grass as received.

No. 1. *Jinfi*.—This grass was found to contain :

	Per cent.
Moisture	8·9
Cellulose	50·9 [1]
Ash	4·0

[1] *Equivalent to* 55·8 *per cent. in the moisture-free material.*

The ultimate fibres measured from 0·6 to 3·5 mm. in length, with an average of 1·9 mm.

The results of examination of this grass were as follows:

Trial.	Caustic soda used.		Conditions of boiling.		Caustic soda consumed per 100 parts of grass.	Yield of dry pulp.
	Parts per 100 parts of grass.	Parts per 100 parts of solution.	Time.	Temp.		
			Hrs.	° C.		*Per cent.*
A	16	3	5	140	10·5	53·5
B	20	3·5	5	140	11·2	47·5
C	20	3·5	7	160	14·3	44·0

The pulp produced in Trial A with 16 parts of caustic soda per 100 parts of grass did not break up completely in the beater, but it bleached satisfactorily to a pale cream colour. In Trial B with 20 parts of caustic soda a somewhat better result was obtained, but the treatment was still insufficient. With the more drastic treatment of Trial C, however, a pulp was obtained which broke up fairly well in the beater, and after bleaching and further beating gave a well disintegrated product furnishing a good white paper of excellent strength.

No. 2. Gamba.—This grass was found to contain:

	Per cent.
Moisture	8·8
Cellulose	49·3[1]
Ash	3·8

[1] *Equivalent to* 54·0 *per cent. in the moisture-free material.*

The ultimate fibres measured from 0·6 to 2·6 mm. in length, with an average of 1·4 mm.

The results of examination of the grass were as follows:

Trial.	Caustic soda used.		Conditions of boiling.		Caustic soda consumed per 100 parts of grass.	Yield of dry pulp.
	Parts per 100 parts of grass.	Parts per 100 parts of solution.	Time.	Temp.		
			Hrs.	° C.		*Per cent.*
A	16	3	5	140	9·6	51·0

Treatment under these conditions proved just sufficient to produce a pale-brown coloured pulp which broke up fairly readily on beating, and on bleaching and further beating gave a well disintegrated pulp of good felting power. The resulting paper was strong, opaque, and of good quality.

It will be seen that this sample of grass required less caustic soda for its disintegration than the Jinfi grass (No. 1), although both grasses were identified at Kew as *Andropogon Gayanus.* This is no doubt due to the fact that the Gamba grass was on the whole much thinner and had apparently been gathered at an earlier age than the Jinfi grass (Sample No. 1).

No. 3. *Sasari.*—This grass was found to contain :

	Per cent.
Moisture	8·8
Cellulose	44·6[1]
Ash	6·1

[1] *Equivalent to* 48·9 *per cent. in the moisture-free material.*

The ultimate fibres measured from 0·8 to 3·2 mm. in length, with an average of 1·6 mm.

The grass gave the following results on examination :

Trial.	Caustic soda used.		Conditions of boiling.		Caustic soda consumed per 100 parts of grass.	Yield of dry pulp.
	Parts per 100 parts of grass.	Parts per 100 parts of solution.	Time.	Temp.		
			Hrs.	° C.		*Per cent.*
A	16	3	5	140	10·0	49
B	20	3·5	5	140	12·0	46

The pulp produced in these experiments was very similar in character to that yielded by the Jinfi grass (No. 1). Treatment with 16 parts of caustic soda did not prove sufficiently drastic, but the use of 20 parts of caustic soda gave pulp which disintegrated satisfactorily and bleached readily. The pulp thus obtained had excellent felting powers and furnished a good white paper of excellent quality.

No. 4. *Tsauri.*—This grass was found to contain:

	Per cent.
Moisture	9·1
Cellulose	50·0 [1]
Ash	5·0

[1] *Equivalent to* 55·0 *per cent. in the moisture-free material.*

The ultimate fibres measured from 0·7 to 2·0 mm. in length, with an average of 1·3 mm.

The following table shows the results of examination of this grass:

Trial.	Caustic soda used.		Conditions of boiling.		Caustic soda consumed per 100 parts of grass.	Yield of dry pulp.
	Parts per 100 parts of grass.	Parts per 100 parts of solution.	Time.	Temp.		
			Hrs.	° C.		*Per cent.*
A	16	3	5	140	10·2	51·0
B	24	4	9	140	13·8	43·5
C	24	4	9	160	16·0	41·0

The pulp obtained in Trial A with only 16 parts of caustic soda contained much incompletely disintegrated fibre, parts of which were still visible in the paper made from the bleached pulp, and even under the more drastic conditions of Trial B the pulp was not sufficiently broken down. In Trial C, however, in which the temperature was increased to 160° C., a satisfactory result was obtained, the pulp being readily disintegrated in the beater, and, after bleaching, giving a paper of good strength and fairly satisfactory colour.

No. 5. *Yama.*—This grass was found to contain:

	Per cent.
Moisture	9·3
Cellulose	40·9 [1]
Ash	7·6

[1] *Equivalent to* 45·1 *per cent. in the moisture-free material.*

The ultimate fibres measured from 0·7 to 2·1 mm. in length, with an average of 1·4 mm.

The grass gave the following results on examination:

Trial.	Caustic soda used.		Conditions of boiling.		Caustic soda consumed per 100 parts of grass.	Yield of dry pulp.
	Parts per 100 parts of grass.	Parts per 100 parts of solution.	Time.	Temp.		
			Hrs.	° C.		*Per cent.*
A	16	3	5	140	10·0	49·0
B	20	3·5	5	140	14·2	47·5
C	24	4	9	140	14·8	42·0

The pulp produced in Trial A with only 16 per cent. of caustic soda contained a quantity of coarse fibre which was not disintegrated on beating. A better result was obtained in Trial B, but even in this case the pulp did not break up sufficiently in the beater. Trial C gave a pulp which broke up fairly well on first beating, whilst on bleaching and further beating a well disintegrated pulp was obtained which furnished a strong, fairly white paper of good quality.

No. 6. *Kitsi Gujma.*—This grass was found to contain:

	Per cent.
Moisture	8·9
Cellulose	42·0[1]
Ash	6·3

[1] *Equivalent to* 46·1 *per cent. in the moisture-free material.*

The ultimate fibres measured from 0·5 to 2·2 mm. in length, with an average of 1·2 mm.

Pulping trials with this grass gave the following results:

Trial.	Caustic soda used.		Conditions of boiling.		Caustic soda consumed per 100 parts of grass.	Yield of dry pulp.
	Parts per 100 parts of grass.	Parts per 100 parts of solution.	Time.	Temp.		
			Hrs.	° C.		*Per cent.*
A	16	3	5	140	9·0	44·0
B	20	3·5	5	140	12·5	42·5

The pulp obtained in Trial A contained a fairly large proportion of coarse, unbroken fibre, which, however, was somewhat reduced during the bleaching treatment. A better result was produced in Trial B, the pulp breaking up fairly readily in the beater, and, after bleaching and further beating, yielding a well disintegrated material which

produced a strong paper of good quality and satisfactory colour.

This grass was identified at Kew as representing the same species as No. 5 (Yama), but the sample consisted of rather thinner and less mature stems than the latter and therefore required less drastic treatment.

No. 7. Baya Maria.—This grass was found to contain:

	Per cent.
Moisture	9·2
Cellulose	42·9[1]
Ash	5·0

[1] *Equivalent to* 47·2 *per cent. in the moisture-free material.*

The ultimate fibres measured from 0·4 to 2·6 mm. in length, with an average of 1·3 mm.

The results of a pulping trial with this grass were as follows:

Trial.	Caustic soda used.		Conditions of boiling.		Caustic soda consumed per 100 parts of grass.	Yield of dry pulp.
	Parts per 100 parts of grass.	Parts per 100 parts of solution.	Time.	Temp.		
			Hrs.	° C.		*Per cent.*
A	16	3	5	140	10·7	45·0

The pulp thus obtained did not break up sufficiently on first beating, but after bleaching and further treatment in the beater a well disintegrated pulp was obtained which yielded a strong, opaque paper of satisfactory quality and good colour.

It will be seen from the Kew identification quoted on page 275 that this sample consisted of a mixture of three distinct grasses, one of which (*Andropogon Gayanus*) is identical with that represented by Samples No. 1 (Jinfi) and No. 2 (Gamba).

No. 8. Wuchiyan Bera.—This grass was found to contain:

	Per cent.
Moisture	8·3
Cellulose	47·6[1]
Ash	3·1

[1] *Equivalent to* 51·9 *per cent. in the moisture-free material.*

The ultimate fibres measured from 0·5 to 2·0 mm. in length, with an average of 1·3 mm.

The results of examination of the grass were as follows :

Trial.	Caustic soda used.		Conditions of boiling.		Caustic soda consumed per 100 parts of grass.	Yield of dry pulp.
	Parts per 100 parts of grass.	Parts per 100 parts of solution.	Time.	Temp.		
			Hrs.	° C.		*Per cent.*
A	16	3	5	140	12·0	46·5
B	20	3·5	5	140	15·0	45·0

The pulp obtained in Trial A contained a large amount of incompletely disintegrated fibre, some of which resisted the bleaching process and was clearly visible in the otherwise fairly white paper produced. Trial B with 20 per cent. of caustic soda yielded a pulp which, after bleaching, broke up fairly satisfactorily in the beater and furnished a strong white paper.

The results of the examination of these samples show that the grasses on the whole give very satisfactory yields of pulp, and that the pulps have good felting properties and are capable of producing strong papers of good quality. The yields of pulp from Samples No. 2 (Gamba), No. 3 (Sasari), No. 7 (Baya Maria), and No. 8 (Wuchiyan Bera) compare favourably with those obtained from Spanish esparto grass when treated under the same conditions.

The pulps are of similar character to one another and closely resemble esparto pulp, although the ultimate fibres are rather shorter. In most cases they bleach easily, and they would all be suitable for the production of good class writing papers.

It will be seen that in some cases more drastic treatment was required than in others to reduce the grass to pulp. The yield of pulp and the treatment required doubtless depend to some extent on the age and condition of the grass, as is seen in the case of Samples Nos. 1 and 2, which are botanically identical but differed in condition, and similarly in the case of Nos. 5 and 6. In no case, however, was the treatment required in any way unusual, and with

fresh material, if possible representing somewhat younger grass, even less severe treatment would probably suffice.

The export of these grasses from Nigeria would not be remunerative owing to their bulky nature and the consequent high cost of freight, but it would be worth while to consider the possibility of their utilisation locally for the preparation of pulp in the form of "half-stuff" for export.

CEYLON TIMBERS

SPECIMENS of mahogany and of timbers suggested for use as substitutes for boxwood have been forwarded recently from Ceylon for investigation at the Imperial Institute. The results of their examination are dealt with below.

MAHOGANY

Three baulks of timber of *Swietenia macrophylla* were sent for examination. This species is now generally recognised as the botanical source of the mahogany shipped from British Honduras, and distinct from *S. Mahagoni* from which other Central American mahogany as well as Cuban and West-Indian mahoganies are derived. A considerable quantity of the seed of *S. macrophylla* was sown in Ceylon nearly thirty years ago, in the Sundapola plantation of the Forest Department, near Kurunegala, with successful results. The tree has readily adapted itself to the locality, and is already spreading by natural reproduction. It produces long, straight, clean boles, which in 1917 had attained an average girth of 4 feet at chest height. The Conservator of Forests states that under proper sylvicultural conditions the trees would probably attain an average girth of 6 feet when forty to fifty years old, with a clean bole of 30–50 feet, and yield about 5,000 cubic feet of timber per acre. The area under this mahogany in Ceylon is being extended, but it is not anticipated that supplies of timber for export will be available for many years.

The wood examined at the Imperial Institute was obtained from the Nuwara Eliya Division. The baulks

measured 9 feet in length and 12 by 6 inches in cross section. The wood was in sound condition, and was of a light red tint which darkened on exposure. The grain was fine and even and the surface was smooth and cool to the touch.

In transverse section the wood was of a brick-red colour, with fine, fairly closely distributed pores, visible to the eye. The rays were seen as fine, light-coloured lines, equidistant and slightly wavy; the rings were defined as lighter coloured concentric lines. The pith was brownish-red, soft and spongy, and about ⅜ inch in diameter.

In radial section the wood was of a lighter shade and the pores were seen as fine grooves. The rays appeared as parallel red lines, whilst the rings were not well defined, but were indicated by alterations in the rays.

In tangential section the wood had a similar appearance to that shown in the radial section, except that the rays were visible in short lines and the rings were indicated by lighter and darker shades.

The wood worked excellently with tools of all kinds and gave an excellent finish when planed, carved, or turned. It polished well, and gave strong joints on being dovetailed and grooved.

The weight per cubic foot was 35·6 lb.

The mahogany was submitted to the Imperial Institute Advisory Committee on Timbers, who considered that it was of particularly fine quality, but inclined to be "knotty." They were of opinion that no difficulty would be experienced in selling such wood if it were offered in commercial quantities and free from knots. The trees should be cut if possible to yield planks not less than 22–24 inches in width.

Boxwood Substitutes

The timbers of three Ceylon trees, viz. Ceylon boxwood or pandaru (*Canthium didymum*), wira (*Hemicyclia sepiaria*) and etteriya (*Murraya exotica*), were examined in order to ascertain their suitability as substitutes for true boxwood.

1. *Ceylon Boxwood* (*Canthium didymum*)

This tree, which occurs also in India, Malaya and South China, grows in the low country of Ceylon and up to a

height of 4,000 feet in the wet zone. It belongs to the natural order Rubiaceæ. The tree only reaches a moderate size, and the wood, which is little used locally, is not obtainable in large dimensions. It receives its local name of Ceylon boxwood from its heavy, hard and fine-grained character. Timber of this tree was received from three districts in Ceylon, the samples in two cases consisting of three logs, and in the third case of one log, all of them being 4 feet in length and nearly circular in cross-section.

No. 1. *From Uva Division.*—These logs measured respectively 3, 4 and 5 inches in diameter. The bark, which varied in thickness from $\frac{1}{16}$ to $\frac{5}{32}$ inch, consisted of a brown corky outer layer which was easily peeled off and an inner greyish-brown layer firmly attached to the wood.

No. 2. *From Nuwara Eliya Division.*—The diameters of these logs were 5, $5\frac{1}{2}$ and 6 inches respectively, and the bark was about $\frac{1}{8}$ inch in thickness.

No. 3. *From Kurunegala Division.*—The single log from this Division was from 6 to 7 inches in diameter, and was partly covered with bark about $\frac{3}{16}$ inch thick.

The woods from the different districts were found to resemble each other closely in general characters, but the weight per cubic foot varied as follows: *No.* 1, 62·1 lb.; *No.* 2, 58·2 lb.; *No.* 3, 55 lb.

The colour of the wood was light brown to light purplish-brown, and there was a purplish discoloration in one part of each log. The boundary between the sapwood and heartwood was obscure. The surface of the wood was smooth and cool to the touch, and the grain was very fine, close and dense.

In transverse section the wood was purplish-brown, with fine closely distributed pores visible to the eye. The rays were very fine and closely distributed, the rings were clearly defined and narrow, being closest in the wood from the Uva Division (No. 1). The pith was in the form of a lozenge-shaped or bobbin-shaped bar measuring up to $\frac{1}{16}$ by $\frac{3}{16}$ inch in section.

In radial section the colour of the wood was lighter than in transverse section, being light brown to grey. The pores were practically indistinguishable by the naked eye;

the rays were visible as dark flakes and the rings as fine dark lines. The pith appeared as a narrow brown strip.

In tangential section the wood was light purplish-brown. The pores and rings were as in the radial section, and the rays were scarcely distinguishable.

The wood was slightly tougher and harder than true boxwood, and could be worked fairly easily, but it was difficult to drill owing to a tendency to split. It was moderately easy to cut with both power and hand saws, and a good finish was obtainable on planing. The wood turned well, giving a smooth finish, and thin flanges possessed good strength.

2. *Wira Wood* (*Hemicyclia sepiaria*).

H. sepiaria is a small tree or bush belonging to the natural order Euphorbiaceæ. It is very common in the dry zone of Ceylon and also in the dry forest regions of Southern India. The value of the wood is somewhat depreciated by the natural form of the tree, which grows in a gnarled and twisted manner.

Three logs of this wood from the Jaffna Division were received. They were 4 feet in length and from 5 to 6½ inches in diameter, covered with hard, greyish-brown bark which was from $\frac{1}{16}$ to $\frac{1}{8}$ inch thick and firmly attached to the wood.

The colour of the wood varied from light to dark brown, without any definite boundary between the sapwood and heartwood. The grain was extremely fine, close and dense, and the surface smooth and cool to the touch.

In transverse section the wood was yellowish-brown to brown with a slight greyish discoloration in one part of each log and with occasional black patches. The pores were very fine and densely distributed ; the rays fine and not conspicuous. The rings were clearly defined and narrow. The pith was very small, but varied somewhat in size in different parts of the log.

In radial section the wood was light yellow to light brown ; the pores were invisible to the naked eye and the rays just visible as light flakes. The rings were indicated by variations in light and shade with a fine line at the boundary.

In tangential section the wood was lighter than in transverse and radial section ; the pores were perceptible as minute grooves, and the rays were not visible to the naked eye. The rings were well defined as brown lines.

The wood could be worked fairly well with saw, plane and chisel, and an excellent finish was obtained on planing. It was somewhat difficult to drill, but did not split. The wood turned readily, giving a smooth finish, and thin flanges possessed good strength.

The weight per cubic foot was 57 lb.

3. *Etteriya Wood* (*Murraya exotica*)

This is a widely distributed tree, occurring in India, China, Australia and the Pacific Islands. In Ceylon it is found in the low country and up to an altitude of 3,000 feet. It is a small tree, and is sometimes grown for ornamental purposes, as it possesses white fragrant flowers. It belongs to the orange family.

Three logs of the wood from the Anuradhapura Division were received. They were of irregular shape, 4 feet in length and varied in diameter from 4 to 9 inches. The bark was thick and fissured, and peeled off easily in thin layers. The heartwood was brown and the sapwood light yellow.

The wood had a very fine, compact grain, and the surface was smooth and cool to the touch, with a natural lustre and resinous appearance.

In transverse section the heartwood was brown and the sapwood brownish-yellow. The pores were very fine and densely distributed. The rays, except in the outer layers of the sapwood, were only visible with a lens and were very fine and closely packed. The rings were very narrow. The pith measured less than $\frac{1}{32}$ inch in diameter.

In radial section the colour of the wood was lighter than in transverse section, the sapwood being of a light yellow tint. The pores were just visible to the naked eye as fine grooves, closely distributed ; the rays were seen as light parallel flakes more conspicuous in the heartwood than in the sapwood. The rings were indicated by narrow lines.

In tangential section the wood appeared lighter than

in either transverse or radial section. The pores were visible as fine grooves, but the rays could not be seen even with a lens. The rings were indicated by faint lines.

The wood was difficult to saw, plane and drill, on account of its tough nature and tendency to tear and split. A good finish was, however, obtainable with a smoothing plane, and also when the wood was carved. The wood could not be turned satisfactorily.

The weight per cubic foot was 63·2 lb.

Commercial Value of the Woods

The three timbers were inspected by the Imperial Institute Advisory Committee on Timbers, who were of opinion that they were all unsuitable for engraving purposes, but that they might possibly be employed as substitutes for boxwood for turnery or other uses where the appearance of the wood is not of importance.

A firm of timber merchants who were consulted as to the commercial possibilities of the timbers stated that in their opinion the only one which would stand any chance of being accepted as a substitute for boxwood in the United Kingdom is *Hemicyclia sepiaria* (wira), but they pointed out that the presence of black discolorations at the heart and in patches throughout the logs would be prejudicial to its use. It is possible that the young wood might not show these black patches, and if so they suggested that a dozen pieces of the wood of various diameters should be forwarded for practical trial by users. They stated, however, that the present time would not be opportune for an attempt to dispose of consignments in the United Kingdom as the market is at present overstocked with South African boxwood (*Buxus Macowani*) and increasing quantities of true Turkish boxwood are now being received. If, however, logs of wira of satisfactory character can be obtained, it would be of interest to have the possibilities of the wood definitely determined in case an opening should present itself later.

Conclusions

The results of the investigation indicate that these timbers, with the possible exception of wira, would not be

very suitable for use as substitutes for ordinary boxwood and that in any case their export at the present time cannot be recommended. If, however, logs of wira wood free from black discolorations can be obtained, it would be desirable for a small consignment to be sent for technical trials as suggested by the merchants, together with information as to the quantity available.

THE OIL OF THE PHYSIC OR PURGING NUT

THE physic or purging "nut" is the seed of *Jatropha Curcas*, Linn., an evergreen shrub belonging to the natural order Euphorbiaceæ, which is closely related to the Para rubber tree and less closely to the castor and croton oil plants. The plant is indigenous to South America, but has been introduced into most tropical countries. In the Portuguese colonies in Africa it is cultivated for the sake of its seeds, which are exported to Lisbon and elsewhere as a source of curcas oil, utilised mainly for soap manufacture. The oil has purgative and emetic properties, and is used medicinally in some tropical countries. Watt (*Commercial Products of India*, 1908, p. 699) states that numerous cases are on record of poisoning through eating the entire seed.

The results of an investigation at the Imperial Institute of physic nuts from Nigeria were published in this BULLETIN (1904, **2**, 170). During the last year or two, seeds have also been received for examination from the Gold Coast and South Africa, those from South Africa having been produced at a farm at Quivels Kloof in the Northern Transvaal. Oil extracted from the seeds in the Gold Coast and residual cake from Zanzibar have also been examined. An account of this later work is given in the following pages.

Seeds

The seeds from the Gold Coast and South Africa were examined with the following results :

		Gold Coast.	South Africa.
Average weight of seed	*grams.*	0·84	—
Shell	*per cent.*	33	39
Kernel	„ „	67	61
Moisture in seed	„ „	11·1	7·9
Yield of oil	„ „	33	31·9
„ „ expressed on dry seed	„ „	37	34·6

Oil

The oils extracted at the Imperial Institute from the above-mentioned seeds were yellow in both cases. That sent from the Gold Coast was clear, amber-coloured, and free from moisture. The three oils were analysed with the following results, which are shown in comparison with those obtained with oil from Nigerian seed examined previously at the Imperial Institute (*loc. cit.*)

	Oil extracted at Imperial Institute from Gold Coast seed.	Oil received from the Gold Coast.	Oil extracted at Imperial Institute from South African seed.	Oil extracted at Imperial Institute from Nigerian seed.
Specific gravity at 15°/15° C.	0·9191	0·9183	0·9207	0·919
Solidifying point of fatty acids	28·7° C.	28·8° C.	—	—
Acid value[1]	4·5	9·2	3·3	4·5
Saponification value[1]	191·6	193·0	191·1	204
Iodine value *per cent.*	98·7	95·6	104·3	99·1
Acetyl value	25·4	18·7	—	—
Volatile acids, soluble[2]	0·37	0·60	—	—
Volatile acids, insoluble[2]	0·22	0·24	—	—

[1] *Milligrams of potash for 1 gram of oil.*

[2] *Cubic centimetres of decinormal alkali required to neutralise acid from 5 grams of oil.*

It had been suggested that curcas oil might be used as a lubricant in place of castor oil. Viscosity tests were therefore carried out on the three oils in comparison with a commercial sample of castor oil, with the following results :

	Viscosity in seconds for 50 cc. at 70° F.
Curcas oil:	
Gold Coast (1)	298
„ „ (2)	290
South Africa	284
Commercial castor oil	3,888

The three samples of curcas oil and the commercial castor oil were also exposed in thin films on glass, under varying conditions, with the results summarised below :

(1) After 22 hours at a temperature of 100° C. the

curcas oils had darkened, but had not dried completely; whilst the castor oil remained unaffected. At the end of 26 hours the curcas oils were quite dry, but the castor oil was still unchanged.

(2) When exposed to light and air the curcas oils showed slight signs of drying after seven days, but the castor oil was unaffected.

From these results it is clear that curcas oil differs widely in viscosity and drying properties from castor oil, and could not replace the latter for lubricating certain types of machinery (*e.g.* aeroplane engines) for which castor oil is particularly suited.

Cake

In forwarding the sample of purging-nut cake the Director of Agriculture, Zanzibar, stated that the seed is imported into Zanzibar in fairly large quantities from Portuguese territory and Madagascar for use in the local soap trade, but that, if desirable, the plant could easily be grown in the island.

The cake had been prepared from undecorticated seed, and was in the form of broken pieces and coarse powder of a brownish-grey colour.

Owing to the fact that this oil-cake always contains some oil, it cannot be employed as a feeding-stuff, and is best utilised as a manure. The cake was therefore analysed as a manure and furnished the following results, which are shown in comparison with corresponding figures recorded for undecorticated castor-seed cake :

		Jatropha Curcas cake.	Castor-seed cake (undecorticated).
		Per cent.	*Per cent.*
Moisture	H_2O	10·4	—
Nitrogen	N	3·2	3·67
Phosphoric acid	P_2O_5	1·4	1·60
Potash	K_2O	1·2	1·12
Soda	Na_2O	0·21	—
Chlorine	Cl	0·13	—
Sulphuric acid	SO_3	0·08	—
Ash		5·6	—

The ash of the *Jatropha Curcas* cake contained the following constituents :

		Per cent.
Phosphoric acid	P_2O_5	25·7
Potash	K_2O	20·7
Soda	Na_2O	3·8
Chlorine	Cl	2·4
Sulphuric acid	SO_3	1·5

It is evident from these results that the cake has a high value as a manure, being approximately as rich as castor-seed cake in nitrogen and phosphoric acid. The ash obtained on burning the cake would form a valuable concentrated manure, or the potash might be extracted and utilised locally for soap-making.

General Conclusions

Curcas oil is mainly utilised for soap manufacture, and there should be no great difficulty in disposing of the seeds or the oil for that purpose in the United Kingdom if they can be offered in commercial quantities. As already stated, however, the residual cake or meal has purgative properties and could not be utilised as a feeding-stuff, but only as a manure, and would therefore realise a relatively low price.

THE AFRICAN OIL PALM IN CEYLON

In this Bulletin (1920, **18**, 167) an account was given of the results of examination at the Imperial Institute of the fruits and nuts of the African oil palm produced from trees of the "Abe-pa" variety grown experimentally at the Experiment Station, Anuradhapura, Ceylon. It was found that the kernels gave a good yield of oil, but the pericarp was poorer in oil than that of fruits of the same variety grown in the Gold Coast. In order that further determinations of the yields of palm oil and palm kernel oil from the fruits might be made, two samples were forwarded from Ceylon in November 1920, and the results of their investigation are given below.

The fruits received were as follows:

No. 1. "Green Variety."—These were dried palm fruits of dull yellow to pale brown colour, with rather thin pulp

and thick-shelled nuts. About 7 per cent. of the nuts contained two kernels.

No. 2. "*Black Variety*."—These fruits were similar to No. 1, but were mostly of a reddish-brown colour. About 10 per cent. of the nuts contained two kernels.

The results of the examination of the fruits are shown in the following table in comparison with those obtained for the previous samples from Anuradhapura (*loc. cit.*), and also with those furnished by two samples of "Abe-pa" fruits from the Gold Coast (see this BULLETIN, 1909, **7**, 368):

	Present samples.		Previous samples examined in 1920.		"Abe-pa" from the Gold Coast.	
	No. 1 (green).	No. 2 (black).	(1)	(2)	(1)	(2)
Fruits						
Average length . *in.*	1·10	1·07	1·1	—	1·55	1·2
" diameter . *in.*	0·72	0·69	0·75	—	0·95	0·8
" weight . *grams.*	4·7	3·7	5·1	—	12·2	7·0
Pulp . . *per cent.*	27·7	27	23	—	31	29
Nut . . *per cent.*	72·3	73	77	—	69	71
Pulp						
Moisture . *per cent.*	4·3	3·9	4·5	—	13·6	16·3
Oil, *per cent.* Expressed on moist pulp . .	65·8	64·5	62·7	—	69·2	65·0
Oil, *per cent.* Expressed on dry pulp . .	68·8	67·1	65·6	—	80·0	77·6
Nuts						
Average length . *in.*	0·84	0·84	0·8	0·7	1·2	1·0
" diameter . *in.*	0·65	0·63	0·7	0·5	0·85	0·7
" weight *grams.*	3·4	2·7	3·5	1·6	8·3	4·4
" thickness of shell *in.*	0·09	0·08	0·11	0·08	—	0·15
Kernel . . *per cent.*	25·1	25·6	22·5	25	25	31
Shell . . *per cent.*	74·9	74·4	77·5	75	75	69
Kernels						
Average length . *in.*	0·54	0·54	0·5	0·4	0·8	0·7
" diameter . *in.*	0·45	0·41	0·4	0·3	0·55	0·4
" weight *grams.*	0·8	0·7	0·8	0·4	2·1	1·6
Moisture . *per cent.*	6·3	6·1	5·5	5·4	23·7	20·0
Oil, *per cent.* Expressed on moist kernels . .	53·7	53·1	52·6	55·5	—	41·0
Oil, *per cent.* Expressed on dry kernels . .	57·3	56·5	57·8	58·8	—	51·0

The palm oil obtained from the pulp of No. 1 was pale yellowish-brown, whilst that from the pulp of No. 2 was of deep orange tint.

The fat from the kernels of both samples was of pale cream tint and had the normal appearance of palm kernel oil.

General Conclusions

The results of the present investigation show little variation from those previously obtained with " Abe-pa " palm nuts forwarded to the Imperial Institute from Anuradhapura. The following general conclusions may be drawn from the investigation :

(1) The " Abe-pa " fruits and nuts produced at Anuradhapura are considerably smaller than those of the same variety of palm in the Gold Coast.

(2) The amount of pulp in the Ceylon fruits is rather less than in " Abe-pa " fruits from the Gold Coast.

(3) The yield of palm oil, expressed on the dry pulp (66 to 69 per cent.), is rather less than that from the Gold Coast " Abe-pa " fruits (77 to 80 per cent.).

(4) The proportions of shell and kernel are approximately the same in the Ceylon and Gold Coast nuts.

(5) The Ceylon kernels yield more fat (56 to 59 per cent. expressed on the dry material) than the Gold Coast " Abe-pa " kernels (51 per cent.).

It will be seen that the green and black varieties of fruit now under report differ very little in yields of pulp, kernels, palm oil and palm kernel oil, but that any differences which exist are generally in favour of the green variety, the kernels of which moreover are slightly larger than those of the black variety.

Although the yields of palm oil from these fruits are lower than those obtained at the Imperial Institute from " Abe-pa " fruits from the Gold Coast, they are satisfactory, and the yield of fat from the kernels is very good.

GUERE PALM NUTS FROM COLOMBIA

THE nuts of the guere palm of Colombia have recently been examined at the Imperial Institute as a source of oil. The nuts were similar in appearance to those of species of *Astrocaryum*. It was, however, found impossible at

Kew to determine the species from the material received, which consisted of endocarp and seed only, but it was stated that the specimens appeared to come nearest to *Astrocaryum Tucuma*, Mart.

The nuts were about 1¼ in. in length and ⅞ in. in greatest diameter, and had an average weight of about 8·2 grams. They consisted of shell 60 per cent. and kernel 40 per cent. The shell, which was about ⅛ in. in thickness, was hard and brittle. The kernel, which was in most cases loose inside the shell, was about ⅞ in. in length and covered with a thin, hard, brown, closely adhering skin. The interior was white, hard and oleaginous. The average weight of the kernel was 3·3 grams.

The kernels contained 6·2 per cent. of moisture and 37·6 per cent. of fat, which is equivalent to a yield of 40·0 per cent. of fat from the dry kernels.

Fat.—The fat was pale cream coloured and fairly hard. It possessed a faint, not unpleasant odour, resembling that of palm kernel fat.

The fat was examined with the following results, which are compared with figures recorded for the fat from the kernels of *Astrocaryum vulgare* and for palm kernel fat:

	Present sample.	*Astrocaryum vulgare* fat.		Palm kernel fat (*Elaeis guineensis*).
		(1)	(2)	
Melting point	35·5° C.	30·5° C.	29·4°–32·5° C.	26°–29° C.
Specific gravity 100°/15° C.	0·864	0·867	—	0·873
Solidifying point of fatty acids	29·7° C.	27·0° C.	—	20·0°–25·5° C.
Acid value[1]	1·7	2·9	—	—
Saponification value[1]	249·6	249·0	240–245	245–248
Iodine value, *per cent.*	9·4	11·6	12·2–13·9	14–17·5

[1] *Milligrams of potash for 1 gram of oil.*

The fat is quite equal to palm kernel fat, and would sell readily for edible purposes.

Meal.—The residual meal left after the extraction of the fat from the kernels was pinkish-cream and had a faint taste slightly resembling that of coconut. This meal was submitted to chemical examination with the following results, which are shown in comparison with those recorded

for the meal of *Astrocaryum vulgare* nuts, palm kernel cake and coconut cake :

	Present sample as prepared.	Present sample calculated to contain 7 per cent. of fat.	Residual meal of *Astrocaryum vulgare* nuts.	Palm kernel cake.	Coconut cake.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	10·0	9·6	8·4	9·4	11·9
Crude proteins	7·7	7·4	10·0	17·8	21·8
Fat	3·1	7·0	7·0	8·2	8·4
Carbohydrates, etc. (by difference)	67·3	64·6	62·9	50·6	42·6
Fibre	9·9	9·5	9·5	10·1	9·4
Ash	2·0	1·9	2·2	3·9	5·9
Nutrient ratio [1]	1 : 9·6	1 : 10·9	1 : 7·9	1 : 3·9	1 : 2·8
Food units [2]	94	101	105	116	118

[1] *The ratio between the percentage of crude proteins and the sum of the percentages of starch and fat, the latter being first converted into its starch equivalent.*

[2] *The total obtained by adding the percentage of starch to 2·5 times the sum of the percentages of fat and crude proteins.*

No alkaloids or cyanogenetic-glucosides were present in the meal.

Guere kernels in good condition should be readily saleable in the United Kingdom, but would fetch a lower price than palm kernels, which usually contain about 50 per cent. of fat, as compared with 37·6 per cent. in the present sample.

The residual meal would have only a moderate value as a feeding-stuff owing to the low percentage of proteins. It is inferior for the purpose to either palm kernel cake or coconut cake.

A NEW FODDER GRASS FROM UGANDA

A SAMPLE of grass from Uganda has recently been examined at the Imperial Institute in order to ascertain its value as a fodder. The grass was identified at the Royal Botanic Gardens, Kew, as *Pennisetum polystachyum*, Schult. Information as to its precise distribution is not yet available, but it appears to be an East Indian plant, and found also in Jamaica. Several species of *Pennisetum* are esteemed as fodder grasses, the best known being *P. purpureum*, the elephant grass, which has a wide distribution in Africa

between 10° N. lat. and 20° S. lat.; it is grown in Rhodesia under the name of "Napier's Fodder" (cf. this BULLETIN, 1914, **12**, 127). Other species used are *P. longistylum* (Kikuyu grass) of British East Africa (*loc. cit.*, 1921, **19**, 214) and *P. ciliare* and *P. dichotomum* of Somaliland. *P. typhoideum*, the bulrush or spiked millet and the bajra of India, is grown to a large extent, chiefly for its grain, in Africa and India.

The grass examined at the Imperial Institute consisted of plants of pale greenish-straw colour, from 26 to 45 inches long and bearing immature seed heads. The material as received contained 7·4 per cent. of moisture. It was examined with the following results, which are expressed on the moisture-free material, in comparison with the corresponding figures recorded for elephant grass (*P. purpureum*) and timothy grass:

	Present sample. (*P. polystachyum*).	Elephant grass. (*P. purpureum*).		Timothy grass.
		(1)	(2)	
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Crude proteins	9·9	10·5	7·6	8·1
Fat	2·7	1·5	0·8	3·1
Carbohydrates, etc. (by difference)	38·6	41·4	45·3	52·6
Fibre	40·1	38·8	38·7	30·7
Ash	8·7	7·8	7·6	5·5
Nutrient ratio[1]	1 : 4·5	1 : 4·3	1 : 6·2	1 : 7·4
Food units[1]	70	71	66	81

[1] *For meaning of these terms see p. 295.*

The sample was found to be free from cyanogenetic glucosides.

It will be seen from these figures that the *Pennisetum polystachyum* grass from Uganda contains a slightly higher percentage of protein than that present in timothy grass, and also compares satisfactorily with *P. purpureum* in this respect.

THE MANUFACTURE OF TILES IN EAST AFRICA

THE provision of roofing material for buildings in the tropics is often a matter of some difficulty. Corrugated iron is largely employed, but it is frequently very costly, and, moreover, tends to make the building unbearably hot. In several countries in Africa it has been suggested that roofing tiles should be made locally, and search has been made for suitable materials. Specimens of clay and sand, collected in Uganda, and of clay, shale and diatomite from Kenya Colony, have recently been examined at the Imperial Institute, and the results of the investigation are given in the present article. As diatomite does not seem to have been used hitherto for making roofing tiles, the trials now reported are of special interest.

UGANDA

The materials received from Uganda consisted of blue and yellow clays and swamp sand. The clays are stated to occur beneath an overburden of about 10 feet of stony clay and lumps of white material, possibly a diatomite, which is used locally as white-wash. The layer of blue clay is 4 feet thick, beneath which is the yellow clay. The swamp sand is available in extensive quantities and is used locally in a mixture for wall plaster.

The *blue clay* consisted of slate-grey clay mottled with veins and patches of yellow ochreous material, together with some siliceous and micaceous matter. The clay readily broke down in water, producing a plastic mass containing small lumps of the ochreous material.

The *yellow clay* was brownish-yellow and mottled with dark and white patches. It contained a large quantity of hard ochreous matter, together with small stones, sand and mica. On treatment with water it behaved similarly to the blue clay described above.

The *swamp sand* was a moderately fine sand containing a fair quantity of clayey matter.

The blue and yellow clays in their crude condition were found to be unsuitable for tile manufacture owing to the high shrinkage on firing (12·3 per cent. and 11·1 per cent.

respectively) and the irregular mottling due to the presence of ochreous material. With a view to reducing the amount of impurity present, some of the dry crude clay was lightly " rubbed down " in a pestle and mortar, care being taken not to break up any of the hard lumps of non-clayey material, and was afterwards passed through a sieve having 20 meshes to the linear inch. The product thus obtained from each clay was mixed with 20 per cent. of the swamp sand (previously passed through a 20-mesh sieve) and with sufficient water to form a mass possessing good working properties.

A tile moulded from each mixture was air-dried and fired to a temperature of 900°–920° C. for about 6½ hours. Strong tiles, suitable for ordinary purposes, were thus produced, but their appearance was marred by numerous small red and black streaks. The total shrinkage was 6·7 per cent. in the case of the blue clay and 4·3 per cent. in that of the yellow clay.

As the " rubbing down " method did not eliminate the smaller particles of impurities present, it was considered that the clays might be more efficiently purified by a process of washing to remove the ochreous matter, sand and mica. The quantity of material removed by this treatment amounted to about 8·5 per cent. in the case of the crude blue clay and about 30 per cent. in that of the crude yellow clay. The washed clays resulting from the operation were dried for two hours at 100° C. and were then analysed with the following results :

		Washed blue clay. *Per cent.*	Washed yellow clay. *Per cent.*
Alumina	Al_2O_3	26·77	16·25
Ferric oxide	Fe_2O_3	3·19	5·14
Titanium dioxide	TiO_2	1·33	1·45
Lime	CaO	1·14	trace
Magnesia	MgO	0·49	0·62
Silica	SiO_2	54·91	54·21
Potash	K_2O	0·50	0·70
Soda	Na_2O	0·58	1·11
Loss on ignition		11·24	20·29

The swamp sand was also dried and analysed, with the following results :

No.	Mixture	Water added	Temperature of firing	Duration of firing	Total shrinkage	Tensile strength	Water absorption	Water permeability	Colour	Ring
		Per cent.	*° C.*	*Hours.*	*Per cent.*	*Lb. per sq. inch.*	*Per cent.*	*Minutes.*		
1	Raw unwashed clay	—	1,000	6	12·3	—	19·4	19·75	—	—
2	"Rubbed down" clay, 80 per cent. Swamp sand, 20 per cent.	26·7	900–920	6½	6·7	—	18·5	31·75	Dull pink, streaked	—
3	Washed clay, neat	24·4	1,000	6	—	236	—	—	—	—
4	Washed clay, 80 per cent. Swamp sand, 20 per cent.	26·0	1,000	6	9·2	518	14	23·25	Buff	Good
5	Washed clay, 60 per cent. Swamp sand, 40 per cent.	21·4	1,000	6	6·5	282	13·4	14	Buff	Fairly good
6	Washed clay, 50 per cent. Swamp sand, 50 per cent.	21·0	1,000	6	5·1	—	15·5	13·5	Buff	Bad
7	Washed clay, 40 per cent. Swamp sand, 60 per cent.	20·6	1,000	6	3·4	95	14·5	4	Buff	Very bad
8	Washed clay, 30 per cent. Swamp sand, 70 per cent.	20·6	1,200	6	7·8	—	11·9	2·5	Light yellow ochre[3]	Very bad
9	Washed clay, 20 per cent. Swamp sand, 80 per cent.	21·1	1,200	6	7·2	—	12·0	2	Light yellow ochre[3]	Very bad

TABLE II. UGANDA. TILES MADE FROM BLUE CLAY AND "GROG"

No.	Mixture. Blue clay and "grog."	Water added.	Temperature of firing.	Duration of firing.	Total shrinkage.	Tensile strength.	Water absorption.[1]	Water permeability.[2]	Colour.	Ring.
		Per cent.	*° C.*	*Hours.*	*Per cent.*	*Lb. per sq. inch.*	*Per cent.*	*Minutes.*		
10	Washed clay, 80 per cent. Grog, 20 per cent.	23·0	1,000	6	9·5	754	14·7	15·5	Light buff	Very good
11	Washed clay, 60 per cent. Grog, 40 per cent.	21·0	1,000	6	6·8	626	18·1	6·5	Buff	Good
12	Washed clay, 40 per cent. Grog, 60 per cent.	20·0	1,000	6	3·7	375	19·7	4·5	Buff	Good

[1] *The absorption of water by a Yorkshire plain tile under similar conditions was 17 per cent.*

[2] *Measured by the time taken in minutes for water to penetrate the tile, which was 12 mm. in thickness. The permeability of a Yorkshire plain tile under similar conditions was 64 minutes.*

[3] *These tiles were unavoidably exposed to a slightly "reducing" atmosphere during firing.*

		Per cent.
Silica	SiO_2	88·66
Alumina	Al_2O_3	5·28
Ferric oxide	Fe_2O_3	2·00
Lime	CaO	0·55
Magnesia	MgO	0·25
Soda	Na_2O	0·06
Potash	K_2O	0·04
Loss on ignition		2·36

The results of tile-making trials with the washed clays were as follows :

1. *Blue Clay.*—Tiles made from mixtures of the washed blue clay and the swamp sand in varying proportions were carefully air-dried and fired to a temperature of 1,000° C. for six hours, except in the case of two tiles (Nos. 8 and 9), which were fired to 1,200° C., as these mixtures yielded weak tiles on firing at the lower temperature. Briquettes similar to those used for cement testing by the British Standard Specification were also made from the same mixtures, and fired at 1,000° C. in order to ascertain the tensile strengths of the fired materials.

The results obtained in these experiments are shown in Table I (page 299). It will be seen that fairly strong tiles can be made from mixtures of the washed blue clay with quantities of the sand up to about 40 per cent. of the total, but that when firing is carried out at about 1,000° C. this percentage of sand is the maximum amount that can be added to the clay without undesirably reducing the strength of the burnt tile.

It was thought possible that stronger tiles might be made by using " grog " prepared from the blue clay itself, in place of the swamp sand. Grog was therefore made by firing the clay at 1,100° C. for six or seven hours and grinding it to pass a sieve of 50 meshes to the linear inch. Mixtures of the clay and grog in similar proportions to those previously used were then made, and tested with the results shown in Table II (page 299). All these tiles were sound and strong, those made from the mixtures containing 20 per cent. and 40 per cent. of grog being considerably stronger than the tiles made from the washed clay and 20 per cent. of sand. The tile resulting from the mixture containing 60 per cent. of grog was of good appearance,

No.	Mixture	Per cent.	° C.	Hours.	Per cent.	Lb. per sq. inch.	Per cent.	Minutes.		
13	Raw unwashed clay	—	1,200	4	—	—	17·1	17·75	—	—
14	"Rubbed down" clay, 80 per cent. Swamp sand, 20 per cent.	—	900–920	6	—	—	23·0	8·25	Light terra-cotta	Fair
15	Washed clay, neat	28·0	1,000	6	—	304	—	—	—	—
16	Washed clay, 80 per cent. Swamp sand, 20 per cent.	23·3	1,000	6	5·6	223	20·1	8·25	Light red	Good
17	Washed clay, 60 per cent. Swamp sand, 40 per cent.	22·0	1,000	6	4·3	128	18·7	5·25	Light red	Bad
18	Washed clay, 50 per cent. Swamp sand, 50 per cent.	22·6	1,200	4	7·2	—	15·5	3	Light Indian red[3]	Fairly good
19	Washed clay, 40 per cent. Swamp sand, 60 per cent.	22·5	1,200	4	6·5	75	15·9	3	Light Indian red[3]	Fairly good
20	Washed clay, 30 per cent. Swamp sand, 70 per cent.	20·6	1,200	4	5·9	—	14·7	2·75	Light Indian red[3]	Bad
21	Washed clay, 20 per cent. Swamp sand, 80 per cent.	22·2	1,200	4	5·2	—	15·4	2·25	Light Indian red[3]	Bad

TABLE IV. UGANDA. TILES MADE FROM YELLOW CLAY AND "GROG"

No.	Mixture. Yellow clay and "grog."	Water added.	Temperature of firing.	Duration of firing.	Total shrinkage.	Tensile strength.	Water absorption.[1]	Water permeability.[2]	Colour.	Ring.
		Per cent.	° C.	Hours.	Per cent.	Lb. per sq. inch.	Per cent.	Minutes.		
22	Washed clay, 80 per cent. Grog, 20 per cent.	29·0	1,000	6	7·4	262	18·5	3·5	Light Indian red	Very good
23	Washed clay, 60 per cent. Grog, 40 per cent.	27·0	1,000	6	6·3	220	21·5	3·25	Light Indian red	Good
24	Washed clay, 40 per cent. Grog, 60 per cent.	30·0	1,000	6	5·6	161	23·5	2·25	Light Indian red	Good

[1] *The absorption of water by a Yorkshire plain tile under similar conditions was 17 per cent.*
[2] *Measured by the time taken in minutes for water to penetrate the tile, which was 12 mm. in thickness. The permeability of a Yorkshire plain tile under similar conditions was 64 minutes.*
[3] *These tiles were unavoidably exposed to a slightly "reducing" atmosphere during firing.*

but not so strong as that made with 20 per cent. of sand, but was superior both in "ring" and tensile strength to that yielded by the mixture containing 40 per cent. of sand.

It will be noticed that the porosity of both the "sand" and "grog" tiles, as measured by the water absorption, approximated closely to that of a Yorkshire plain tile, but that their permeability was much greater.

2. *Yellow Clay*.—Tiles made from mixtures of the washed yellow clay and the swamp sand in varying proportions were carefully air-dried and fired at temperatures of 1,000° and 1,200° C. Briquettes similar to those made with mixtures of the blue clay and swamp sand were also prepared in order to ascertain the tensile strength of the fired materials. The results of the experiments, given in Table III (p. 301), indicate that about 20 per cent. of sand is the maximum amount that can be employed in mixtures of the yellow clay and sand, if firing is to be carried out at about 1,000° C. With a mixture containing 40 per cent. of sand the resulting tile is weak. Fairly strong tiles can be produced by firing mixtures containing 50 and 60 per cent. of sand to 1,200° C.; but this temperature is in excess of that usually employed in tile burning.

As in the case of the blue clay, experiments were also carried out with mixtures of the yellow clay and grog made from the clay itself. The results, given in Table IV (page 301), show that the mixtures of yellow clay and grog are generally somewhat superior for tile manufacture to those of the yellow clay and swamp sand. The tile produced from the mixture containing 20 per cent. of grog was decidedly stronger than that yielded by the mixture containing 20 per cent. of sand. The tile made from the mixture containing 40 per cent. of grog had practically the same tensile strength as that containing 20 per cent. of sand, and the mixture containing 60 per cent. of grog yielded a better tile than one containing 40 per cent. of sand. It will be observed, however, that in every case the tensile strength of the tiles made from mixtures containing grog was lower than that of a tile made with the washed clay alone.

The tiles made from mixtures of the yellow clay and grog were, however, much inferior to those made from the

blue clay and grog, a 60 per cent. grog mixture in the latter case yielding a tile superior in tensile strength to that given by a 20 per cent. grog mixture made with the yellow clay.

The remarks made with regard to the porosity and permeability of the blue clay tiles (see p. 302) are equally applicable to those made with the yellow clay.

General Conclusions

The results of the foregoing experiments show that neither the blue nor the yellow clay is suitable in the crude state for tile manufacture. Tiles of good quality can, however, be made from mixtures of the washed clays and the swamp sand, with a maximum of 40 per cent. of sand in the case of the blue clay and 20 per cent. in the case of the yellow clay.

Good tiles can also be made from mixtures of the washed clays with up to as much as 60 per cent. of grog, the tiles produced in this manner with the blue clay being considerably stronger than those made with the yellow clay. The blue clay, moreover, contains only 8·5 per cent. of impurities as compared with 30 per cent. in the yellow clay, and would therefore be easier and more economical to wash.

From the experiments conducted at the Imperial Institute it would appear that 1,000° C. is a suitable temperature for firing tiles made from either the blue or the yellow clay. In connection with the use of grog for mixing with the clay, it would not always be necessary (except in the initial stages) to burn the clay specially for the purpose of making grog, as defective or broken tiles could be ground and utilised for the purpose.

KENYA COLONY

The materials from this Colony consisted of one sample of clay and two samples of Jurassic shale from the mainland opposite Makupa, which were stated to have been used successfully for brick making, and two samples of diatomite from the Rift Valley.

I. *Clay and Shales*

The samples consisted of a buff-coloured plastic clay (No. 1) containing small amounts of quartz sand, and two buff-coloured shales (Nos. 2 and 3) containing some quartz and a little calcareous matter. The three materials were analysed with the following results :

		No. 1.	No. 2.	No. 3.
		Per cent.	*Per cent.*	*Per cent.*
Silica (free)	SiO_2 .	33·60	34·22	34·64
Silica (combined)	SiO_2 .	25·10	23·03	22·28
Alumina	Al_2O_3 .	16·19	13·22	14·31
Ferric oxide	Fe_2O_3 .	4·74	5·81	7·48
Titanium dioxide	TiO_2 .	1·07	1·43	1·08
Manganous oxide	MnO .	trace	0·74	0·06
Lime	CaO .	0·91	3·91	3·14
Magnesia	MgO .	1·65	2·32	2·55
Soda	Na_2O .	2·38	0·82	0·98
Potash	K_2O .	1·30	3·32	2·18
Sulphuric anhydride	SO_3 .	0·77	0·24	0·18
Phosphoric anhydride	P_2O_5 .	0·04	0·30	0·27
Loss on ignition .	. .	13·38	10·89	11·23

The analyses show that the three samples are similar in chemical composition.

Technical trials to determine the suitability of the clay and shales for the production of tiles were carried out with material which had been ground to pass a 20-mesh sieve. The results were as follows.

It was found undesirable to use the clay No. 1 in its crude state, as it was very plastic and sticky, and tiles made from it warped badly on air drying, whilst the shrinkage on firing was excessive. In order to obviate these defects, the crude clay was therefore mixed with varying amounts of the burnt clay (grog), which was prepared by firing the clay at 1,100° C. and grinding it to pass a sieve of 20 meshes to the linear inch.

The tiles were moulded by hand, and, after being allowed to dry in the air, were fired at a temperature of about 900° C. The results of the trials are shown in the following table :

No.	Composition of tile.	Colour after firing.	Linear shrinkage on air drying.	Further linear shrinkage on firing.	Total linear shrinkage.	Weight of finished tile.
			Per cent.	*Per cent.*	*Per cent.*	*Lb. per cubic foot.*
1	Crude clay (No. 1)	Light yellowish-brown	not determined		13·7	129
2	Crude clay (No. 1) 75 per cent., grog from clay (No. 1), 25 per cent.	Light brick-red	7·2	2·6	9·8	128
3	Crude clay (No. 1) 50 per cent., grog from clay (No. 1), 50 per cent.	Light brick-red	7·8	1·0	8·8	121
4	Crude shale (No. 2)	Brick-red .	5·2	2·6	7·8	115
5	Crude shale (No. 3)	Brick-red .	5·2	1·3	6·5	119

The tiles made from the clay No. 1 alone showed considerable warpage and contraction, and those made from the shales Nos. 2 and 3 alone showed some surface cracks and specks of lime. The tiles made from a mixture of the clay and 25 to 50 per cent. of grog were, however, strong and sound and showed only slight warpage.

The water permeability, *i.e.* the time in minutes taken by water to penetrate the tiles, was determined in the case of the tile made from the clay with 50 per cent. of grog and that made with shale No. 2. The permeability in the first case was six minutes, and in the second from five to eleven minutes, as compared with sixty-four minutes for a Yorkshire plain tile of equal thickness. The tiles made from these materials from Kenya are, therefore, much more permeable by water than Yorkshire plain tiles, and this fact will have to be taken into consideration in connection with their use for roofing purposes. This point is further discussed in the section relating to the tiles made from diatomite (page 309).

The tensile strength of tiles made with shale No. 2 was found to be 936 lb. per sq. in. for a tile which had been heated to 900° C., and 922 lb. per sq. in. for a tile heated to 990° C.

The foregoing results show that the clay No. 1 is not suitable in the crude state for tile-making owing to its sticky nature and tendency to shrink, but that good tiles can be produced if the crude clay is mixed with a certain proportion of grog.

The tiles made from shales Nos. 2 and 3, which contained a small quantity of calcite, showed a few small white spots after burning. As a general rule, materials containing pieces of calcite or dolomite should not be used for the manufacture of tiles, as the burnt product is usually defaced by white spots of lime, which, on exposure to air, may hydrate and cause "blowing." In the present samples of shale most of the lime was present in a finely divided state, but in both samples there were occasional small pieces of calcareous matter up to ⅛ inch in diameter which gave rise to the small white spots in the burnt tiles. This defect was much less noticeable with shale No. 2 than with No. 3, and it is possible that tiles suitable for local use could be produced from material represented by sample No. 2.

Occasionally the raw materials used for tile manufacture are washed in order to remove chalk or limestone; but this seems scarcely possible in the case of the present samples owing to their shaly character.

II. *Diatomite*

The diatomites were as follows:

No. 1. *Diatomite from Elementeita.*—This consisted of fairly white diatomite, containing much clay and some quartz in the form of small crystals which made the material somewhat gritty.

No. 2. *Diatomite from Naivasha.*—This consisted of pale buff-coloured diatomite containing some clay; it was iron-stained in parts.

Chemical analyses of representative portions of the two diatomites gave the following results:

		No. 1. Per cent.	No. 2. Per cent.
Silica	SiO_2	52·15	70·37
Alumina	Al_2O_3	30·48	8·38
Ferric oxide	Fe_2O_3	3·79	4·53
Titanium dioxide	TiO_2	0·59	0·22
Lime	CaO	0·40	1·04
Magnesia	MgO	0·23	0·51
Potash	K_2O	0·12	0·52
Soda	Na_2O	0·37	1·02
Loss on ignition		12·72	13·70

Tile.	Percentage composition of tile.		Colour after firing.	Total shrinkage.	Water absorption by weight.	Water permeability.[1]	Tensile strength in lb. per sq. inch.		Weight of tile (after firing).	Strength of the tiles.
							Tiles fired at 900° C.	Tiles fired at 990° C.		
				Per cent.	*Per cent.*				*Lb. per cubic foot.*	
	Diatomite No. 1	*Diatomite No. 2*								
P	100	—	Buff	5·9	32	11	79[2]	76	92·2	Weak
Q	—	100	Light brick-red	7·8	46	6	350[2]	172	62·7	Strong
R	50	50	Light brick-red	5·9	34	30	—	—	77·2	Strong
S	33·3	66·6	Pale yellowish-red	7·8	36	12	—	—	71·7	Strong
	Diatomite No. 1	*Clay No. 1*								
N	95·2	4·8	Buff	4·6	30	11	—	—	93·9	Weak
A	90·9	9·1	Light buff	7·8	31	5	126	—	95·0	Weak
B	80	20	Buff	5·9	27	—	—	—	96·5	Fairly strong
C	66·6	33·3	Buff	9·8	21	45	364	442	101·1	Strong
	Diatomite No. 1	*Shale No. 2*								
O	95·2	4·8	Buff	4·6	31	12	—	—	93·9	Weak
D	80·0	20·0	Buff	3·9	—	20	—	—	100·5	Fairly strong
E	66·6	33·3	Reddish-buff	5·9	24	12	—	—	105·6	Fairly strong
	Diatomite No. 2	*Clay No. 1*								
F	90·9	9·1	Light brick-red	10·1	29	13	456	126	77·4	Strong
H	80·0	20·0	Light brick-red	8·5	29	—	547	493	78·2	Strong
K	66·6	33·3	Light brick-red	9·8	28	—	—	—	78·2	Strong
	Diatomite No. 2	*Shale No. 2*								
L	80	20	Light brick-red	7·8	40	6	478	503	66·3	Strong
I	66·6	33·3	Light brick-red	7·8	37	5	265	368	73·2	Strong
—	Yorkshire plain tile			—	17	64	—	—	104·8	Strong

[1] *The time in minutes taken for water to penetrate the tile.*
[2] *The tensile strengths of the air-dry diatomite tiles P and Q before firing were* 10 *and* 108 *lb. per sq. inch respectively.*

Owing to the amount of clay present in sample No. 1 it showed considerable plasticity when mixed with water, but No. 2 exhibited this property to a much less degree.

Technical trials were carried out at the Imperial Institute in order to determine whether light roofing tiles could be produced from these diatomites. Experimental tiles were made by using (*a*) the diatomites alone, (*b*) mixtures of the two diatomites, and (*c*) mixtures of the diatomites with the clay (No. 1) and also with shale No. 2 (see p. 304). As shales Nos. 2 and 3 are very similar in properties, the conclusions as to the value of No. 2 for this purpose will apply equally to No. 3.

The materials before being moulded into tiles were ground to pass a 50-mesh sieve and were then pugged with the minimum quantity of water necessary to give coherent tiles. The mixtures of diatomite No. 2 with the clay (No. 1) and with shale No. 2 were somewhat resilient and therefore rather difficult to mould by hand.

After air drying, the tiles were all strong enough to bear handling and were then fired at temperatures of about 900° C. and 990° C. The composition and physical characters of a number of the tiles are shown in Table V (page 307), together with corresponding figures for Yorkshire plain tiles.

Character of Tiles fired at 900° *C.*—The results show that the tiles made from diatomite No. 2 are markedly superior in strength to those made from No. 1, and that mixtures of diatomite No. 2 with shale or clay yield in most cases much stronger tiles than similar mixtures in which diatomite No. 1 is employed. Experiment M is the only instance in which a mixture of diatomite with clay or shale is weaker than the corresponding neat diatomite. The percentage increase in strength caused by the addition of clay or shale was much greater with diatomite No. 1 than with No. 2.

In general, the results indicate that a strong tile can be produced by firing diatomite No. 2 at about 900° C., but that at this temperature diatomite No. 1 gives a weak product. If a sufficient quantity of clay or shale were added, the mixtures with diatomite No. 2 would be less resilient and therefore easier to mould by hand, but the

finished tiles would be correspondingly heavier. It is possible that a different method of manufacture, such as moulding by compression, might overcome the difficulty caused by the resilience of the moist material.

Character of Tiles fired at 990° C.—These tests show some rather interesting results, as in three cases only, viz., tiles C, L and M, do they show increases in strength. In this connection it may be stated that tiles P, N, A, O, which were weak after firing to a temperature of about 900° C., were re-fired to 1,080° C., but no appreciable increase in strength was thereby produced.

The results indicate that there is little or no advantage to be gained by firing at a temperature of 990° C., and in most cases the lower temperature of 900° C. is preferable.

General Remarks.—Tiles made from mixtures of diatomite No. 1 and the clay or shale were both weaker and heavier than those made from diatomite No. 2. A mixture of diatomite No. 1 with half its weight of clay or shale furnished tiles of approximately the same weight as a Yorkshire plain tile of the same dimensions.

The porosity of the majority of the tiles is much higher than that of Yorkshire plain tile, the water absorption in the case of tiles made from diatomite No. 2 being as much as 46 per cent. as compared with 17 in the case of the Yorkshire plain tile. An objection which may be raised to porous roofing tiles is that, as they are rapidly permeated by rain, water might possibly drip from the under-surface. Experiments with the tiles at the Imperial Institute have indicated, however, that rain would probably flow over them without dripping through; but in order to decide this question it would be necessary for trials to be carried out under the rainfall conditions of Kenya Colony. If it should be found by such trials that rain does penetrate the tiles, it would be desirable to glaze the upper surfaces.

In this connection experiments were carried out at the Imperial Institute to determine the possibility of applying glazes (both lead and leadless) to the tiles at a temperature of about 850° C. Promising results were obtained, but should the glazing of tiles in Kenya Colony be considered feasible it would be desirable to submit specimens of the tiles to experts in order that the composi-

tion of a glaze suited to the body of the tile may be determined.

An attempt was also made at the Imperial Institute to salt-glaze tiles B, H, and K at 1,200° C., the temperature at which salt-glazing is usually performed. After glazing, tiles H and K, which had become very dark in colour, were found to be bent, pitted and blistered, and considerable contraction had taken place. Tile B had also contracted considerably, and had moreover not taken the glaze. The results thus indicate that salt-glazing is unsuitable for these tiles.

It seemed possible that a light tile might be produced by using Portland cement as a binding agent for the diatomite. Experiments were therefore made in order to ascertain how much cement would be needed, and it was found that in order to produce a tile of sufficient strength it was necessary to mix diatomite No. 1 with 10 per cent. of cement, and that diatomite No. 2 required as much as 40 per cent. of its own weight of cement. In view of these facts and the high price of imported cement in Kenya Colony no further experiments were made with cement-diatomite mixtures.

Experiments were also made in order to ascertain whether a useful material could be produced by mixing the diatomites with a "selenitic cement" made from a mixture of lime and plaster of Paris or gypsum. Although the mixtures hardened well under water and remained sound over a long period, when removed from the water and exposed to air they developed cracks after a few days and were thus rendered useless.

Conclusions.—The results of the experiments made at the Imperial Institute indicate that diatomite No. 2 is suitable for the manufacture of a light, strong, porous tile, either alone or mixed with suitable clay or shale. Tiles made from mixtures with clay are in general stronger than those made from the neat diatomite, but are somewhat heavier. Diatomite No. 1 is less suitable than diatomite No. 2 for tile making, as the tiles produced are not so light as those made from No. 2 and are in general much weaker. They are, however, more compact than those made from No. 2 and approximate in weight to an ordinary clay tile.

If a very light roofing tile is required, diatomite No. 2 might be used, as the tiles produced would be about 39 per cent. lighter than Yorkshire plain tiles of the same size. A stronger but slightly heavier tile could be made from this diatomite by mixing it with a suitable quantity of clay or shale, as shown in the table of results given on p. 307. If it is desired to use diatomite No. 1 for this purpose it would be advisable, in order to obtain the necessary strength, to mix it with about 33 per cent. of the clay (No. 1). The tiles thus produced would, however, after firing be only 3·5 per cent. lighter than Yorkshire plain tiles.

SPECIAL ARTICLE

THE IRRITATING HAIRS OF THE WILD SILK MOTHS OF NIGERIA

By A. W. J. Pomeroy, M.B.E., F.E.S.,

Government Entomologist, Nigeria

It has been previously noted by several authors,[1] that the large communal nests made by the larvæ of the genus Anaphe, when received in the natural state for manufacture, contain numerous hairs which in a dry state are intensely irritating to the skin. It seems to be the general opinion that it is the larval hairs found in these nests which cause this irritation, but, after an extended series of experiments, the writer is convinced that this is not the case, and that the irritation is caused solely by hairs from the end of the abdomen of the moths; these hairs are left in the nests by those adults which find difficulty of egress from the nest during emergence, and which in many cases die within the interior.

The larval hairs are of two kinds—long, flexible hairs, and short, spine-like hairs. Both these types of hairs, however, as far as can be ascertained at present, are of essentially the same morphological structure and arise

[1] Michel, E., "Note sur certains Vers-a-soie sauvages du Congo Belge," *L'Agron. Trop.*, vol. vi, No. 4, April 1914, Part II, pp. 33–45. This Bulletin, 1915, **13**, 109; 1920, **18**, 32.

from exactly the same type of tubercle (see fig. 1, p. 313).

The hairs arise from the centre of a short chitinous cylindrical process superimposed on a well-defined tubercle, the rim of which shows striations. The outer wall of the hair is chitinous, and the interior appears to be filled with tissue containing pigment granules and possibly cells between which the air can pass. When the hairs are placed in alcohol or xylol, the air forms into bubbles, some of which travel the entire length of the hair, stop near the apex and disperse through the chitin, whilst others escape at the base. The pigment is either black, white or brown, according to the species or type of hair. When hairs from specimens preserved in alcohol were placed direct in xylol, a bright greenish tinge often appeared in the centre space, which may be merely an optical effect or may possibly be due to some chemical action. The long, flexible hairs are decidedly more pointed at the apex and the lateral spines are much longer than in the case of the short spine-like hairs (see figs. 2–5, p. 315). These hairs are not readily detached from the living larvæ, and do not float about in the air as is so often the case with the hairs of the larvæ of the brown-tail moth, *Euproctis chrysorrœa*, and other similar species. The writer has preserved many of the larvæ by the common method of inflating the skins with air after removing the contents, using the fingers unprotected during the process of affixing the skin to the glass tube, and has found that the stout, spine-like hairs do not become detached and that they are so resilient that they do not pierce the skin even after drying in the oven. The long hairs occasionally break off, but do not pierce even the tender part of the skin.

During the process of making the large parchment-like cover of the nest, the larvæ denude themselves of the long hairs which are sparsely distributed between the parchment-like layer and the soft outer cover and occasionally woven in the silk tissue, but the greater number are found loose in the interior, in a powdered mass, at the end through which the moths emerge. They can be wiped out readily with a cloth, as the interior layer of the envelope has a glazed surface. The short hairs are retained until

PLATE VIII

WILD SILK MOTHS OF NIGERIA

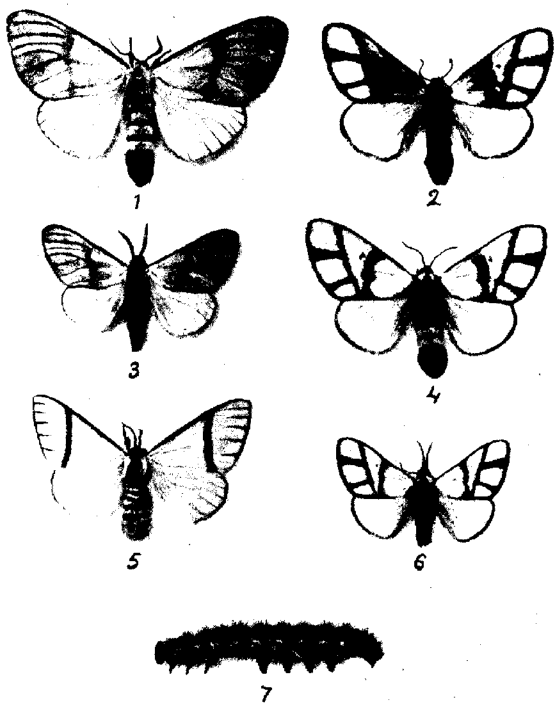


FIG. 1.—*Anaphe venata*, Butl., ♀. FIG. 2.—*A. infracta*, Wals., ♀, dark variety.
FIG. 3.—*A. venata*, ♂. FIG. 4.—*A. infracta*, ♀.
FIG. 5.—*A. moloneyi*, Druce, ♀. FIG. 6.—*A. infracta*, ♂.
FIG. 7.—Larva of *A. infracta*.

Fig. 1.—Full-grown Larvæ of *Anaphe infracta* gathered together preparatory to spinning communal nest.

Fig. 2.—Communal nest of *Anaphe infracta*. To the left of the adult female may be seen the egg mass and a few scattered eggs. The egg mass is not normally laid so, but placed on the underside of the leaves of the food plant, *Bridelia micrantha*.

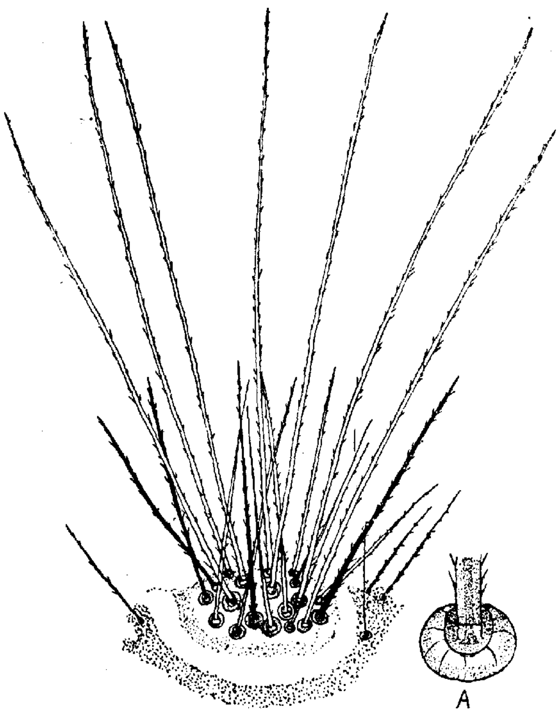


FIG. 1.—The tubercles and hairs of the larva of *A. infracta.*
A—Tubercle showing point of attachment of hair.

the larvæ spin the individual cocoons, and are cast with the larval skin at the final ecdysis. This is a most important fact, as the short, spine-like hairs, which appear somewhat analogous to the spine-like hairs of such larvæ as the moths of the genus Pachypasa, are thus left in the cocoons, except for the chance of a larva not spinning, and therefore do not come in contact with the stout envelope which is the chief part of the silk for commercial use.

The great difference, however, between the larvæ of Anaphe and Pachypasa, is that in the former the hairs are not urticating, and do not become detached and pierce the skin, while in the latter the urticating spines of some species are pointed at both ends, are distinctly barbed, can even be thrown out into the air by the muscular action of the larvæ, and in a few seconds penetrate the skin, causing the most intense irritation.

The writer has many times takent he powdered mass of hairs from the interior of Anaphe nests and rubbed them on the underside of the wrists without obtaining the least symptoms of irritation, the skin of the subject in question being more than normally sensitive. Some irritation may be caused to the mucous membranes by these hairs if inhaled, but the same condition may be found due to the action of lint fibres, dust and other irritants. This action is certainly eliminated in the ordinary process of degumming the silk.

An important point with regard to the structure of the larval hairs is that they bear lateral spines and are not barbed. It would appear, therefore, that these spines instead of assisting penetration would rather retard it, and it may be considered that the hairs are for defensive purposes only; they are certainly never detached for offensive purposes, like those of the moths.

The hairs from the abdomen of the moths on the contrary are usually strongly barbed and intensely irritating to the skin and mucous membranes. During oviposition and in captivity the moth flutters the wings while denuding herself of hairs with which to cover the egg mass, and the air becomes full of these minute hairs, which on settling on the skin, penetrate in a few seconds, causing the most intolerable itching. The same effect is produced by hand-

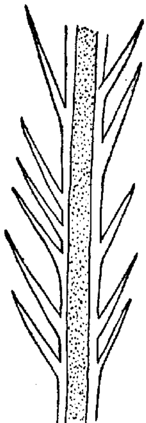


Fig. 2

Fig. 3

Fig. 5

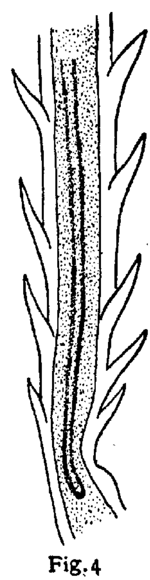


Fig. 4

FIG. 2.—Section of the middle portion of a hair from the larva of *A. infracta.*
FIG. 3.—The pointed end of a long hair from the larva of *A. infracta.*
FIG. 4.—The basal portion of a short spine-like hair from the larva of *A. infracta.*
FIG. 5.—The pointed end of a short spine-like hair of the larva of *A. infracta.*

ling dried specimens of the moths, and even the tough skin of a negro is strongly affected. The injury results in a painful erythema, which sometimes lasts two days, pustules often appearing.

These hairs completely cover the end of the abdomen of the female moth and are closely massed together. They are curved, hollow, strongly chitinous, and are usually barbed on each side at one end, the barbs extending in some cases almost the entire length of the hair. One end is pointed, and is fixed in a cylindrical socket which appears to be formed by the epidermis. The hairs differ considerably according to the various species. Of the four species studied, one species only, *A. ambrizia,* has no barbs. The hairs in this case are rather short, very curved and stout in structure, pointed at one end and rounded at the other. Those of *A. infracta* are pointed, "spear-shaped," at one end, and appear to have a slight indentation at the apex of the other, forming a small knob; they are strongly barbed almost two-thirds of their length. In *A. venata* the hairs are pointed at one end rather more obtusely, barbed almost the entire length, the other end being more obliquely rounded. *A. moloneyi* is remarkable, as the round end of the hair is developed into a distinct spatulate vesicle; the pointed end is strongly barbed about one-third the entire length of the hair (see figs. 6–13, p. 317).

The question of the origin of the irritant properties of the hairs—whether it is due to mechanical action, chemical action, or both—is at present very doubtful, and considerable morphological and cytological investigation appears necessary before a definite conclusion can be reached. In this article it is the intention to bring forward observations which have been made with regard to the actual effect of the hairs on individuals engaged in the handling of the silk, and the fact that it appears possible to eliminate the difficulty from a commercial standpoint.

During the writer's visit to the mills of Messrs. Reade & Co., Congleton, specimens were shown of *A. infracta* nests received for experimental tests. On examination many of these were found to contain dried adults, and information was given that some of the nests had

Fig.7

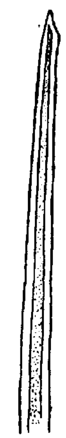
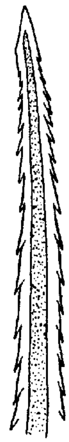


Fig.9

Fig.6

Fig.8



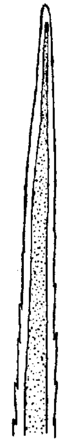


Fig.10 Fig.11 Fig.12 Fig.13

FIG. 6.—Pointed end of hairs from abdomen of female moth *A. infracta.*
FIG. 7.—The rounded end of same.
FIG. 8.—Pointed end of a hair from abdomen of female moth *A. ambrixia.*
FIG. 9.—Rounded end of same.
FIG. 10.—Pointed end of a hair from abdomen of female moth *A. venata.*
FIG. 11.—Rounded end of same.
FIG. 12.—Pointed end of a hair from abdomen of female moth *A. moloneyi.*
FIG. 13.—Rounded end of same which is developed into a vesicle.

contained live pupæ which had produced living adults in England. This undoubtedly accounted for the irritant hairs being distributed over the entire consignment.

It has been found by repeated experiments that with the species *A. infracta*, *A. venata* and *A. ambrizia*, the interior cocoons can be removed from the outside envelope after pupation has taken place with no diminution of the normal ratio of adult emergence, and that the ratio is rather increased, as under natural conditions a certain percentage of the adults fail to emerge owing to the close proximity of the individual cocoons.

By this method the irritant hairs are kept from coming into contact with the envelope, which is the most valuable part of the nest. The silk is also by this means graded and freed from débris and foreign matter. The operation can be done very rapidly. One motion of a sharp knife splitting the envelope the interior can be removed *en masse*, as the individual cocoons adhere closely together.

So much has been written on the subject of the urtication caused by the larval hairs that the writer feels that it is especially necessary to contradict the erroneous statements previously made, in order to allay the apprehensions of the manufacturers that this phenomenon would be likely to prove a very serious difficulty in the utilisation of the silk commercially.

The writer is of the opinion that it is conclusively proved that the larval hairs do not urticate and are a negligible source of irritation, and also that the difficulty caused by the irritant hairs of the moths can be readily overcome by removing the cocoons from the nests, in the country of their origin, before the adults emerge. By adopting this method the propagation of the species is increased, and the silk uniformly graded at the same time.

GENERAL ARTICLES

CINNAMON: SOURCES, PRODUCTION AND TRADE

INTRODUCTION

IN addition to the steady demand for cinnamon bark as a spice, there is a growing demand for it and for the oil distilled from it for use in medicine. The entirely distinct and cheaper oil distilled from the leaves is in still greater demand than that from the bark, largely as a convenient source of eugenol for the manufacture of vanillin. In Western commerce it has long been admitted that cinnamon bark grown and prepared in Ceylon is by far the best; but the Continental market is to an increasing extent satisfied with a cheaper product of coarser flavour from the Far East; in China, the highest price is paid for bark grown in Annam. The preparation of Ceylon cinnamon is laborious and the yield per acre is small, the best Ceylon estates producing only 50 to 100 lb. of quills per acre, as against 1,000 to 2,000 lb. of copra, 400 lb. of rubber, or 600 lb. of tea. Much of the area under cinnamon in Ceylon has consequently been replaced by coconut and Para rubber. The question therefore arises whether the certainly increasing demand can be met by the cultivation of cinnamon in other parts of the Empire.

In the present article an account is given of the production of cinnamon in different parts of the world, and also of that of certain related barks, such as Chinese cassia and Annam "cinnamon."

BOTANICAL SOURCES OF CINNAMON

The genus *Cinnamomum*, to which the cinnamon plant belongs, shares with the rest of the Order Lauraceæ the characteristics of an arborescent habit with evergreen foliage and numerous cavities containing essential oils in the tissues of all parts of the plant. In certain cases, at least, these essential oils vary in composition in different parts of the same plant and at different ages of the various organs. Oil-glands are generally more abundant in superficial structures,

such as the bark and leaves. The Order Lauraceæ, which comprises about a thousand species, is tropical or sub-tropical, and has two chief centres of dispersal—South-east Asia and Brazil; but, while its allied genera, *Sassafras*, *Persea* and *Dicypellium*, are American, *Cinnamomum*, which contains, perhaps, 130 species, is in origin entirely Indo-Malayan.

In Ceylon five species of *Cinnamomum* are recognised, four of which are believed to be endemic, and a species belonging to the allied genus *Litsea* (*L. zeylanica*, Nees), though possessing little aroma or flavour, is so similar in foliage as to be called " Wild Cinnamon " or, in Sinhalese, " Dawul-kurundu." Twenty-six species are enumerated in the *Flora of British India*, only eight of which are dealt with in Watt's *Dictionary of Economic Products*, although three or four others are mentioned in his *Commercial Products of India*. Of these *C. Camphora*, Nees, the main source of ordinary camphor (cf. this BULLETIN, 1920, 18, 524), is a native of Japan, Formosa and China, and has only been introduced on a small scale into India. *C. glanduliferum*, Meissner, the " Malligiri " of Nepal, occurring as far east as Assam, *C. cecicodaphne*, Meissner, the Lepcha " Rohu " and " Gun-droi " of Cachar, belonging to the Eastern Himalayas, especially Darjeeling and Assam, and *C. Parthenoxylon*, Meissner, the Martaban Camphor-wood or " Kayo-gadis " from the Eastern peninsula, have camphoraceous woods used locally for boxes or canoes, and may in some cases have got into foreign botanical gardens in mistake for *C. Camphora*. These four species belong to the sub-genus *Camphora*, distinguished by its usually penninerved leaves from the larger sub-genus *Malabathrum*, which comprises the cinnamon and cassia-yielding species, distinguished by having 3–5-nerved leaves. The forms belonging to this sub-genus cannot be said to be well known or satisfactorily discriminated by botanical characters. *C. Cassia*, long cultivated, is apparently unknown in a wild state, but may be derived from *C. obtusifolium*. *C. Loureirii* may be only a geographical variety of this latter, and *C. Tamala*, the main source of Indian " cassia lignea," is certainly very closely allied to it. The true cinnamon is *C. zeylanicum*,

a native of western and southern India, Tenasserim and Ceylon. It is certain that the oil of cinnamon bark varies in amount and quality according to the altitude at which the tree grows, and *C. iners*, which ranges from Eastern Bengal over Southern India, Burma and Malaysia, where it is a common lowland tree, is suggested by Thwaites and by Ridley (*Spices*, p. 205) as possibly the parent stock of the far more aromatic *C. zeylanicum*.

There has from the earliest times been much confusion in commerce as to the sources of the barks and oils known as cinnamon and cassia, a confusion that is perpetuated by the indiscriminate use by the French of the names *cannelier* and *cannelle* for the trees and their bark, whether the *Cinnamomum zeylanicum* of Ceylon or the *C. Cassia* of Annam and China; and by the use of such names as "commercial cinnamon" and (in the United States) "Saigon cinnamon" for products which are certainly not obtained from the former of these species. It seems tolerably certain that, as Daniel Hanbury concluded, none of the cinnamon of antiquity was derived either from *C. zeylanicum* or from Ceylon. The very name "cinnamon," from the Arabic "mama" or Greek "amomum" (meaning spice) and the prefix "chini," Chinese, which persists in the Persian and Hindustani "Darchini," suggests the Chinese origin of the drug; and, under the name "Kwei," which forms part of several Chinese place-names, cassia is mentioned in the earliest Chinese herbal, said to have been written in 2700 B.C. The mention of "Tien-chu kwei," that is Indian cassia, in the *Pen-tsao*, written in the eighth century, may refer to bark produced in Malabar. The mention of two spices or perfumes, cinnamon and cassia, in the older books of the Old Testament and in the earliest Greek works on medicine, as nearly allied but of different value, may have only referred to two qualities of what we should now call cassia, this latter name—originally "casia"—being related to the Hebrew "ketzioth," meaning "stripped off." The barks were originally brought to Europe—that is to the Levant—by Phœnicians, who obtained them from the Arabs; and the ancient notion that they were derived from a "regio cinnamomifera" in Somaliland may have been merely an error arising from

this trade passing through several hands or part of the common characteristic system of trade mystification. The full Arabic name "Kirfat-ed-darsini," bark of the Chinese tree, shortened into "Kirfah," persists as "Kalfah," the existing Bombay name for Malabar cassia. As Sir Emerson Tennent pointed out (*Ceylon*, i, 575), there is no mention of cinnamon as a product of Ceylon prior to the Arab writer Kazwini, about A.D. 1275, and the Minorite friar, John of Montecorvino, about 1293; and Hanbury makes the highly probable suggestion (*Pharmacographia*, ed. i, 468) that the Chinese, who were acquainted with *C. Cassia*, a very similar tree, and who traded with Ceylon and the coast of Malabar, were concerned in the discovery of the value of the Ceylon bark. The Chalias, the caste to which the peeling and preparation of cinnamon bark is now restricted in Ceylon, are said to have emigrated from India in the thirteenth century; and in the following century Mohammedan writers were well acquainted with Ceylon cinnamon and the difference between it and Chinese and Indian cassia. One of them, writing in 1368 of "Darchini," says "the best is that which comes from Ceylon," while the best Chinese cassia ("salikheh") is, he says, thick, reddish, a little bitter and astringent, but sweeter than Indian Kirfah which "tastes like cloves" (*Pharmacographia Indica*, iii, 204).

The Portuguese, arriving in Ceylon in 1505, found the cinnamon in a wild state, and exacted a tribute of 250,000 lb. of bark annually from the Sinhalese king. Garcia da Orta, about the middle of the same century, speaks of Ceylon cinnamon as worth four times as much as that from Malabar, and the Portuguese occupation of Ceylon in 1536 is stated to have been accomplished chiefly for the sake of the cinnamon. After the Dutch conquest in 1656 the Government monopoly of the export of bark was strictly maintained; but it was under Dutch auspices that, about 1770, the cultivation of the tree was commenced. The entire European demand, stated to have been about 400,000 lb. a year, was then supplied from Ceylon; and, after the British conquest in 1796, the annual production, during the monopoly of the East India Company, which lasted until 1833, did not exceed 500,000 lb. The Dutch began the cultiva-

tion of the tree in Java in 1825; and, while a heavy export duty was imposed on Ceylon bark until 1853, the competition of Javanese bark and of Chinese cassia told upon the Ceylon industry.

Characters and Composition of Cinnamon Oils

C. zeylanicum Bark Oil.—Cinnamon bark oil of commerce is derived principally from the trimmings or chips of *C. zeylanicum* produced in the preparation of the "quills," and also from bark of inferior quality. The yield of oil is usually from about 0·5 to 1·0 per cent., but varies, as do also its properties, according to the method of distillation. The oil is pale yellow in colour, possessing the delicate aroma of Ceylon cinnamon, and having a sweet and pungent taste. English distilled oils, though often more fragrant, generally possess a lower specific gravity, and contain less aldehyde than oils distilled on the Continent. The characters of English and Continental distilled cinnamon bark oil recorded by Parry (*Chemistry of Essential Oils*) are as follows:

	Ceylon Cinnamon Bark Oil.	
	English Distilled.	Continental Distilled.
Specific gravity at $\frac{15°C.}{15°C.}$	0·995 to 1·040	1·020 to 1·040
Optical rotation	0° to −1°	0° to −1°
Refractive index	1·5700 to 1·5850	1·5850 to 1·5910
Aldehyde, principally cinnamic aldehyde (bisulphite method)	58 to 70 per cent.	63 to 76 per cent.
Phenols	5 to 10	4 to 10

In addition to cinnamic aldehyde there have been isolated from Ceylon cinnamon bark oil a number of other constituents, which are responsible for the peculiarly delicate aroma of the oil. These substances consist of 4 to 10 per cent. of eugenol, with small amounts of aldehydes, ketones, alcohols, esters and terpenes.

Cinnamon bark grown in the Seychelles produces oil of inferior odour containing only 22 to 36 per cent. of cinnamic aldehyde and a certain amount of camphor. Like the Ceylon oil it contains eugenol, a sample examined

at the Imperial Institute in 1908 containing 8 per cent. of this constituent.

C. zeylanicum Root-bark Oil.—The root bark furnishes an oil which differs remarkably in composition from that obtained from the other bark of the Ceylon cinnamon tree. It is a colourless liquid containing little or no cinnamic aldehyde, and possesses a strong odour of camphor, which substance separates out on standing. Among other constituents of this oil are small percentages of eucalyptol, eugenol, safrole and borneol. The root-bark oil is not an article of commerce.

C. zeylanicum Leaf Oil.—Ceylon cinnamon leaves yield from 1·5 to 2·0 per cent. of a pale-coloured oil, having an odour of cloves and cinnamon. This oil is very different in composition from that derived from the other parts of the tree, and contains from 70 to 75 per cent. of eugenol (the characteristic constituent of oil of cloves), usually under 3 per cent. of cinnamic aldehyde, and small amounts of other compounds. Cinnamon-leaf oil has a specific gravity of from 1·043 to 1·066; optical rotation, −0° 10′ to + 2° 35′; and refractive index, 1·5300 to 1·5400.

The following species of *Cinnamomum* also yield oils containing a considerable proportion of cinnamic aldehyde.

C. Cassia, Blume.—Whereas the bark, roots and leaves of *C. zeylanicum* yield oils very different in character, oils obtained from all parts of the *C. Cassia* tree are very similar in composition. Cassia oil is generally distilled from the twigs and leaves, which yield from 0·5 to 2·0 per cent. of oil. The oil is yellow or yellowish-brown in colour, and has a strong cinnamon-like odour with a sweet and pungent taste. The oil lacks the delicate fragrance characteristic of *C. zeylanicum* bark oil. The constants of the oil according to Parry are as follows:—Specific gravity D15°C./15°C., 1·055 to 1·072; refractive index, 1·600 to 1·606; optical rotation, − 1° to + 6°; acid value, 6 to 16 (rarely to 20). *C. Cassia* oil contains 80 to 90 per cent. of cinnamic aldehyde and very small amounts of certain other compounds, but no eugenol has been detected in it. Cassia oils containing less than 75 per cent. of cinnamic aldehyde are usually adulterated. Cedar-wood oil, gurjun balsam and fatty oils were formerly the common adulterants. An

admixture of colophony and petroleum is now more frequently employed.

C. Loureirii, Nees.—Various parts of this tree are distilled for oil in Japan. The root bark distilled by Shimoyama furnished 1·17 per cent. of oil consisting chiefly of cinnamic aldehyde. The leaves and young shoots yield 0·2 per cent. of oil, and a sample examined by Messrs. Schimmel & Co. contained 27 per cent. of aldehydes, consisting chiefly of citral together with some cinnamic aldehyde; at least 40 per cent. of the oil was composed of linalool, eugenol and eucalyptol.

C. Burmanni, Blume (*C. Kiamis*, Nees).—Two samples of this bark from the islands of Timor and Celebes, examined by Messrs. Schimmel & Co., yielded 0·5 per cent. of oil with an odour similar to that of *C. zeylanicum* bark oil but less delicate. The oil contained about 77 per cent. of cinnamic aldehyde and 11 per cent. of eugenol.

C. mindanæense, Elmer.—This tree, which is found in the Philippine Islands, is closely related to *C. zeylanicum.* The bark examined by Bacon furnished 0·4 per cent. of oil containing 60 per cent. of aldehydes, principally cinnamic aldehyde.

The following species of *Cinnamomum* contain little or no cinnamic aldehyde.

C. Camphora, T. Nees and Ebermayer.—This species constitutes the camphor tree of China, Formosa and Japan. The wood, leaves and bark are distilled, and furnish from about 0·1 to 3·0 per cent. of oil consisting largely of camphor.

C. Oliveri, Bail.—The bark of this tree growing in Queensland, examined by Hargreaves, yielded 2·4 per cent. of oil containing 18 to 20 per cent. of camphor, 25 to 27 per cent. of safrole, and 40 to 45 per cent. of eugenol methyl ether.

C. Parthenoxylon, Meissn.—The oil from the wood of this tree consists, according to van Romburgh, principally of safrole.

C. pedatinervium, Meissn.—A sample of this bark from Fiji, examined at the Imperial Institute, was found by Goulding (*Jour. Chem. Soc.*, 1903, **83**, 1,093) to yield 0·9 per cent. of oil containing about 50 per cent. of safrole and 30 per cent. of linalool (see this BULLETIN, 1903, **1**, 173).

C. Mercadoi, Vid.—From the bark of this tree, which is

widely distributed in the Philippine Islands, 1·0 per cent. of oil has been obtained by Bacon, which consists largely of safrole.

C. Sintok, Blume.—The bark of this tree yields an oil with an odour of cloves and nutmeg, a sample of which was found to contain 13 per cent. of eugenol.

C. Tamala, T. Nees and Ebermayer.—A sample of oil from the leaves of this tree contained, according to Messrs. Schimmel & Co., 78 per cent. of eugenol.

Canella alba, Murr.—The bark of this tree, occurring in the West Indies, is known as wild cinnamon bark, and furnishes about 1 per cent. of oil containing eugenol and eucalyptol, but little or no cinnamic aldehyde.

Production of Cinnamon and Allied Barks in the British Empire

Ceylon

The cinnamon gardens of Ceylon are situated chiefly in the Southern and Western Provinces, and particularly in the Galle District of the former and the Colombo District of the latter Province. The latest official estimate of the total area under cinnamon is about 35,000 acres in 1919. During the previous ten years there had been on the whole a steady decrease in the area, which in 1909 amounted to nearly 48,000 acres. Figures for the twelve years 1909–1920 are given in the table on p. 328.

In the early part of the last century the export of cinnamon from Ceylon averaged 500,000 lb. per annum. The competition of Java reduced this amount in 1842 to 121,000 lb.; but, soon after, the abolition of export duties in Ceylon brought about an enormously increased output and a consequent fall in price, followed by a return for some years to the 500,000 lb. average. The export of chips for distillation in Europe brought the amount up to 800,000 lb. by 1867 and to nearly 3,000,000 lb. in 1868–9; but during the succeeding quarter of a century the amount fluctuated, mainly on account of the low quality of the bulk of the chips exported. From 1895 to 1899 the figures show an upward tendency, which continued on the whole during the first decade of the present century.

The exports fell away considerably during the later years of the war, but in 1919 they reached the record total of 7,700,560 lb. In the following year, however, only 3,933,552 lb. were exported. The average annual export of bark during a series of periods is shown in the following table; figures for each of the twelve years 1909–1920 are given in the table on p. 328.

	Quantity. lb.	Value.[1] £.
1841—1850	529,461	52,497
1871—1880	1,274,668	64,649
1881—1888	2,088,232	107,604
1901—1910	5,565,684	171,395
1911—1920	5,155,470	134,760

[1] *Converted from rupees at the rate of Rs.* 15 = £1.

Before the war Germany was, as a rule, the largest buyer of both quills and chips; other important countries to which the bark was shipped being the United Kingdom, Spain, Holland, Italy, the United States and Belgium. In 1920 Germany again became an important purchaser, but in that year the United States was the chief buyer of quills. The quantity exported to the chief countries in 1913, 1919 and 1920 is shown in the following table:

	1913.		1919.		1920.	
	Quills.	Chips.	Quills.	Chips.	Quills.	Chips.
	lb.	lb.	lb.	lb.	lb.	lb.
United Kingdom	260,176	371,504	993,440	1,164,240	200,928	180,992
India	—	1,456	160,384	203,840	29,680	10,192
Australasia	16,464	115,238	4,032	33,488	13,776	205,184
Germany	1,135,008	386,400	4,928	—	218,736	134,176
Spain	505,008	72,240	415,072	22,400	287,728	13,440
Holland	87,360	409,584	131,936	69,552	43,680	26,656
Italy	256,032	172,928	92,960	143,472	110,208	171,920
Belgium	79,520	151,648	816,144	623,056	48,720	154,560
France	43,792	24,864	380,352	513,520	87,024	397,488
United States	344,176	53,760	1,442,672	93,408	1,375,024	14,112
Other Countries	530,768	122,874	300,944	90,720	111,328	98,000
Total	3,258,304	1,882,496	4,742,864	2,957,696	2,526,832	1,406,720
Grand Total	5,140,800		7,700,560		3,933,552	

In addition to the bark exported from Ceylon to the United Kingdom, smaller quantities come to this country from Seychelles and other British possessions. A large proportion of the bark, however, is re-exported, particularly

to continental countries. The imports into this country and the re-exports in 1913, 1919 and 1920 are shown in the following tables :

Imports of Cinnamon Bark into the United Kingdom

	From Ceylon.	From Seychelles.	Total from British Possessions.
	lb.	*lb.*	*lb.*
1913 . . .	635,878	100,750	808,387
1919 . . .	2,376,871	282,109	2,850,204
1920 . . .	Figures not available		1,507,632

Re-exports of Cinnamon Bark from the United Kingdom

	To British Possessions.	To Foreign Countries.	Total.
	lb.	*lb.*	*lb.*
1913 . . .	24,790	288,262	313,052
1919 . . .	7,263	1,718,539	1,725,802
1920 . . .	Figures not available		1,116,872

In 1913 the chief countries to which the bark was re-exported were Germany (69,869 lb.), Holland (61,154 lb.), Belgium (24,239 lb.) and Spain (14,878 lb.). In 1919 most of the bark went to Belgium (619,518 lb.), Holland (522,742 lb.) and Spain (155,864 lb.).

The Ceylon Plantation Cinnamon Industry, 1909–1920

Year.	Area under Cinnamon.	Export of Cinnamon Bark.		Export of Cinnamon Bark Oil.		Export of Cinnamon Leaf Oil.	
		Amount.	Value.[1]	Amount.	Value.[1]	Amount.	Value.[1]
	acres.	*lb.*	£	*oz.*	£	*oz.*	£
1909 . .	47,906	6,501,040	181,913	—	—	—	—
1910 . .	47,292	6,306,060	186,219	90,710	1,618	76,008	519
1911 . .	44,584	5,773,140	139,086	49,502	1,131	63,600	453
1912 . .	46,185	5,945,632	188,992	65,972	1,417	34,020	186
1913 . .	46,484	5,140,800	160,908	16,112	715	52,092	354
1914 . .	46,133	4,080,272	107,777	10,129	673	36,936	228
1915 . .	45,133	6,451,984	133,178	36,343	1,698	64,692	1,061
1916 . .	41,753	5,012,896	83,713	62,132	1,620	120,874	1,809
1917 . .	39,930	3,328,192	64,518	78,438	2,655	95,091	1,199
1918 . .	37,969	4,187,680	89,900	62,283	5,109	258,020	5,048
1919 . .	35,083	7,700,560	246,393	66,773	5,655	299,928	6,274
1920 . .	34,662	3,933,552	143,141	73,246	2,577	365,976	5,553

[1] *Converted from rupees at the rate of Rs.* 15 = £1.

Cultivation and Preparation in Ceylon.—The best cinnamon is grown in a very sandy clay or fine white quartz sand, with a good rich sub-soil, at altitudes of less than 1,500 ft., in the strip of land 12 to 15 miles wide, on the south-west coast of Ceylon, between Negumbo, Colombo and Matura, where there is an average temperature of

about 85° F. and a rainfall of about 85 in. annually. Lateritic gravel is stated to produce a quicker growth with coarser bark, and marshy ground to give an undesirable bitterness to the product, which is much less aromatic and probably contains much less oil. The soil must not be rocky or stony; and the rainfall, though it may range from 85 to 100 in., should not be intermitted by prolonged spells of dry weather. Free exposure to sun appears to produce a better quality of bark than does shade. The tree is usually grown from seed in nursery lines, about 9 in. apart, watered and slightly shaded until the seedlings are 6 or 8 inches high, and transplanted when 3, 4 or 12 months old. The seeds are sometimes planted at stake in holes 6 to 12 ft. apart, germinating two or three weeks after being sown; or the plant is propagated by cuttings of very young three-leaved shoots; or by layers. The plants should be transplanted 6 ft. apart, and the ground between them should be weeded from two to four times a year, the weeds being dug in as a green mulch. Manuring with cow-dung or coconut poonac is recommended. The trees are coppiced, the tops being cut when a few inches high so as to induce the formation of stools on which four or five shoots are allowed to grow for about two years, or until the bark begins to turn brown by the formation of a corky layer. The shoots will then be 6–10 ft. high and $\frac{1}{2}$–2 in. in diameter. In some places the main stem of a seedling is not cut until the second or third year, when the cut surface is earthed over. Only two or three of the secondary shoots are cut at first, but the number will increase each year. In some of the cinnamon gardens at Colombo, the stools are very large, dating back, it is supposed, to Dutch times. Adult trees flower in May and fruit in July; and, unless bagged for seed, the entire crop of fruit is liable to be eaten by birds. The ripe fruit is heaped in the shade until the pulp turns black and rots, when the seed can be removed by trampling; the seed is washed and dried in the shade before sowing. Cattle, goats and squirrels nibble the young shoots; but otherwise cinnamon is not very liable to animal or vegetable pests. *Pestalozzia cinnamomi*, Raciborski, is a minute leaf and twig fungus; and the "pink disease" (*Corticium salmonicolor*, B. and Br.), a wet

season disease, well known as attacking Para rubber, forming a pink crust on the stem and destroying the cambium, a sign that the trees are over-crowded, also occurs and can be dealt with by spraying with Bordeaux mixture and excising and burning affected parts. Mites of the genus *Eriophyes* occur in Ceylon and more seriously in Java; but a Traconid hymenopterous insect, probably parasitic on them, has been observed.

The "flush," or growth of young red leaves, follows the first rains; and, as the leaves turn dark green, the sap moves and the shoots when cut can be more readily peeled. This is done mainly in May or, to a less extent, in November. It takes 150 men to cut over 10 acres in two hours, the cut shoots, usually two years old, averaging 3 to 4 ft. in length and ½ to ¾ in. in diameter. Peeling is carried out in Ceylon with a special round-pointed steel knife, two longitudinal cuts being made down the shoot. If the bark does not come away readily, it is rubbed with a smooth piece of hard wood. The slips of bark are then heaped together and covered over for a day or two, so as to be kept moist or, perhaps, to undergo a slight fermentation which facilitates the scraping off of the epidermis and pulpy hypoderm in the process known as "piping." The slips of bark contract into pipes or "quills," which are packed one inside the other, cut square and of uniform length, dried in shade and ultimately in the sun, and eventually made up into bundles of 100 lb. weight, the inferior pipes being 10–15, the better 15–20 to the pound. The prunings and waste pieces obtained in peeling are known as "cinnamon chips," but the name is often extended to pieces of bark, sometimes ⅖ of an inch in thickness, derived from large shoots or thick branches, which are deficient in aroma, cannot be quilled, and are usually known in trade as "cinnamon bark." The chips are very aromatic, and are used for the distillation of oil of cinnamon or powdered for use in mixed spice. They have only been exported from Ceylon since 1867, but now frequently constitute a third or more of the export of bark.

India

In India various barks and twigs are sold either as cinnamon or as cassia lignea; and in the north the leaves

are collected from several forms as a condiment and for use in dyeing and vinegar manufacture, and trees are cultivated to some extent for their leaves. Cinnamon barks are known as Dálchini or Taj, and the leaves as Tej-pat or Tezpat; but an older name for the latter product was Tamáli, the origin of the specific name of *C. Tamala*; and the southern name Tamalpatra gave rise to the Greek name *Malabathron*, under which, or its Latin equivalents *Folia Malabathri* and *Folia Indi*, the leaves were long known in European medicine. The leaves are obtained principally from *C. Tamala*, T. Nees and Eberm., and its variety *intermedium*, this species being wild in the tropical and sub-tropical Himalayas at altitudes of 3,000 to 7,800 ft., sparingly from the Indus to Sutlej, but common eastward to Sikkim, Sylhet, the Khasia Hills and Assam. It is stated to occur as far south as the Mahanadi and in Burma (*Agricultural Ledger*, 1896, No. 38); but the form of which the leaves are reported to be distilled in Mysore (*Indian Forester*, 1908, **34**, 88) is almost certainly another species, possibly *C. macrocarpum*, Hook. fil. *C. Tamala* is planted over an area of some six square miles in the Khasia and Jaintia Hills of Assam, with jack, betel-nut and other fruit trees, and also in the north of Sylhet. In the former district the seedlings are raised in beds, and transplanted in rows 7 ft. apart when five years old, taking another five years to come into bearing and continuing to bear for a century. In Sylhet the trees are self-sown. Heavy rain followed by bright sunshine is most congenial, continuous rain being unfavourable and diminishing the aroma of the leaves, and storms causing much damage. The young plants are shaded, and only the leaves are used, very little bark being collected in these areas. In Kashmir tej-pat is used as a substitute for pán or betel-pepper, and in Bombay in curries: it takes in Indian cookery the place of bay leaves in Europe; and is also employed in medicine as a carminative. In dyeing it is mixed with myrobolans or with kamala as a clarifier. Tej-pat from *C. Tamala* comes into the Lahore bazaar, and some is imported from Nepal. Both this species and *C. impressinervium* are collected in Darjeeling forests, and some of the Bengal supply comes probably from *C. obtusifolium* (*Agricul-*

tural Ledger, *loc. cit.*, and Watt, *Commercial Products of India*, p. 312). The grey bark of *C. obtusifolium* is said to vary considerably in aroma; but the root-bark which is collected in Martaban is stated by Kurz to be as aromatic as the best Ceylon cinnamon (*Dictionary of the Economic Products of India*, ii, 318). Watt found the natives in Manipur habitually collecting the root-bark of *C. Tamala* instead of that of the stem. It would seem that the better quality of cassia lignea of Indian origin comes from these northern forms, though, owing to the doubtfulness of the sources of most specimens tested, opinions expressed as to the quality of the oil derived from them are conflicting. Though undoubtedly used as an adulterant of true cinnamon oil, the oil of cassia lignea is chiefly used in soap-making. Milburn, however, long ago warned traders against the thicker, darker-coloured cassia of Malabar, partly because of the impurities packed with it (*Oriental Commerce*, 1813, ii, 500), and he also mentions the presence of more mucilage in cassia bark than in that of cinnamon. The barks of several species of the allied genus *Litsœa*, the leaves of some of which smell like cinnamon (probably *L. zeylanica*, "Dawul kurundu," or wild cinnamon, of Ceylon, Burma, Bengal and South India, and *L. sebifera*), are used as adulterants of cassia, and are probably injurious, containing the alkaloid laurotetanine (*Pharmacographia Indica*, iii, 211–214; *Rept. Cent. Indig. Drugs Comm.*, 1901, **1**, 126).

There is no evidence of the cultivation on any commercial scale of the true cinnamon (*C. zeylanicum*) in India, though it may be represented as a wild tree in the Western Ghats. Confusion has arisen from the description under this name of forms probably belonging to *C. iners*, *C. macrocarpum* and *C. Wightii*. Thwaites (*Enumeratio Plantarum Zeylaniœ*, 1864, p. 252) was of opinion that these and others such as *C. obtusifolium* might be mere forms of *C. zeylanicum*, and Beddome (*Flora Sylvatica for Southern India*, 1872, p. 262) says that in the moist forests of the south-west from sea-level up to the highest elevations there are seven or eight well-marked varieties so connected *inter se* by intermediate forms that it is impossible to find constant characters worthy of specific distinction, so that

he is disposed to treat their differences as due chiefly to their local conditions and to class them all as forms of *C. zeylanicum. C. iners*, a lowland species of wide distribution in both peninsulas, has a powerful cinnamic aroma and taste in its inner bark when fresh, though it is never so fragrant as *C. zeylanicum.* It is used by the Malays both medicinally and as a spice, but is recognised as only an inferior substitute for true cinnamon. It probably forms part of the cassia lignea of Southern India, as it is abundant in North Kanara, whence much cassia was formerly exported. When carefully prepared, its smaller branches have been pronounced nearly equal to Ceylon cinnamon. It is known as Jangli dárchini, *i.e.* wild cinnamon; and both its bark and its leaves are employed locally in curries (Ridley, *Spices*, p. 205; Watt, *Dictionary of Economic Products of India*, ii, p. 318).

Experience in Mysore suggests that both growth and quality are so much influenced by soil that trees grown in damp low-lying spots not only require six years or more before becoming peelable, instead of the four or five years necessary on siliceous soil, but even then produce bark so much less aromatic that Ridley speaks of them (*Spices*, p. 210) as "passing towards the wild *C. iners.*" As he says "the ease and luxuriance with which the plant grows does not at all prove that it will be successful as a giver of good bark." Though some planters are said (*op. cit.*, p. 222) to have taken a good deal of trouble, Malabar, Tinnevelly and Tellicherry cinnamon remains decidedly inferior to that of Ceylon, and even to that of Java. In South Kanara, especially North Mangalore, what is termed *C. zeylanicum* (*Indian Forester*, 1921, **47**, 77), but is, perhaps, more probably, at least in part, *C. macrocarpum*, Hook. fil., is stated to grow abundantly at 100 to 700 ft. and fairly up to 3,500 ft., to grow well from self-sown seed, to stand any amount of rain and shade and to coppice well. Four varieties are there recognised by the taste of their leaves: "mitta" or sweet; "pickka," insipid; "tej," pungent; and "kadira" bitter, the leaves of the last two only being collected for distillation. The leaves are not there macerated in sea-water before distillation as they are in Ceylon. The annual output of leaf oil from North Mangalore is about

11,100 lb., Bombay being the chief market. E. M. Holmes (*Pharmaceutical Museum Report*, 1895–1902, p. 55) describes a grey-brown unscraped thick bark from Ootacamund in the Nilgiris as derived from *C. Wightii* and as having " a sharp taste recalling the flavour of nutmeg."

Seychelles

Cinnamon trees were introduced into Seychelles, with other species, from the Dutch East Indies, about 1775, by order of M. Poivre, Intendant of the French Colonies beyond the Cape of Good Hope ; and were for a time cultivated in the Royal Gardens at Mahé. The trees spread through the forests and were neglected until 1908, in which year 1,202 tons of bark, valued at £2,955, were exported. At the same time distillation of oil from the bark of the wild trees was commenced, though the quality and price of the bark was far inferior to that of the cultivated trees of Ceylon, realising locally about a penny per lb. Analysis proved the bark to be essentially identical with that from Ceylon. The tree proved itself well adapted to the porous soil and to the climate, flourishing from sea-level to a considerable altitude, and in well-watered situations reaching 2 ft. in diameter. Such trees yielded 100 lb. of dry bark. The seed is dispersed by birds, especially the Mynah (*Acridotheres tristis*), which during the fruiting season (February–April) prefers the fruits of the cinnamon to those of the capsicums. Many cinnamon trees are grown as supports for vanilla, but only wild trees are felled ; and, as all the larger trees were soon cut down and it was found that trees fifteen years old gave only about 10 lb. of bark and that trees of ten years old gave a profit of not more than Rs. 20 (27*s.*) per acre, it was thought that the bark collecting industry would soon decline. Experiments in Seychelles in the preparation of quills showed that unskilled female labour could not prepare more than 1 lb. a day per head, which would mean a profit on cinnamon cultivation of about Rs. 40 (53*s.*) per acre per annum.

The exports of bark from Seychelles for the years 1908–1919 are shown in the following table :

	tons.		tons.
1908	1,202	1915	189
1909	1,044	1916	184
1910	731	1917	1
1911	964	1918	nil
1912	1,098	1919	275
1913	698	1920	185
1914	589		

Prior to 1915 most of the bark was shipped to Germany, Holland being the next most important customer. In 1915 and later years the bulk came to this country.

The distillation of oil from the wild bark and leaves was begun in Seychelles in 1906, the Colonial Report for that year mentioning the establishment of the apparatus at Sans Souci in Mahé and at Silhouette. A small sample of bark oil sent to the Imperial Institute was found to yield 21·7 per cent. of cinnamic aldehyde and 8·0 per cent. of eugenol, but to differ markedly from the cinnamon bark oil of commerce, and not to be saleable as such in this country (this BULLETIN, 1908, **6**, 111). A price was, however, obtained which was five times that of the leaf oil, viz. Rs. 30 (40*s.*) per litre in Europe, which was three-quarters the price of oil distilled from imported bark in Europe. The bark was not scraped; and, although it was acknowledged that it was best prepared by being left to ferment in a moistened state for a night and then dried for two days in the shade and two mornings in the sun, the practice adopted was merely to dry it for three or four days in the sun. It was not certain whether the economy of labour effected by this practice compensated for the loss in quality. Experiments proved that dried bark gave more than twice the amount of oil obtained from fresh bark, and of a more agreeable odour. The yield was also shown to be strictly dependent on the season at which it is collected, the second or third week of the rains being the best. M. Dupont, Curator of the Mahé Botanical Station, in 1912 feared that the distillation of cinnamon leaf oil might also come to an end owing to the drastic cutting of the trees, combined with the effects of drought and scale insects (*Lecanium tessellatum*); but stated that the damper atmosphere up country would secure the growth of seedlings for any future cultivation of the tree. In 1913 a large distilling apparatus was installed by Mr. d'Emmerez de Charmoy

and by 1915 twelve stills were engaged in the distillation of cinnamon bark and leaf and lemon-grass oils, the export of essential oils increasing sevenfold within three years. During the war the development of the industry was hampered by the impossibility of obtaining modern machinery for steam distillation from Europe; but a Chinese settler set the example of building a small still of wood and iron obtained locally for direct fire distillation: his example was followed by many small-holders; and, on samples being submitted to the Imperial Institute, it was found that there was not much difference between the oils obtained by steam distillation and those from direct fire distillation. The high price reached by cinnamon leaf oil (1s. per oz. in London in August 1916, instead of 4*d.* as formerly) encouraged the manufacturers to devote themselves mainly to this oil, as is shown by the following table of exports, and during 1920 there were 44 distilleries at work, as against 12 in 1915.

Export of Cinnamon Oils from Seychelles.

	Bark Oil.		Leaf Oil.	
	Quantity.	Value.[1]	Quantity.	Value.[1]
	litres.	£	*litres.*	£
1911 . . .	1	0·2	212	56
1912 . . .	—	—	1,543	338
1913 . . .	—	—	3,054	799
1914 . . .	—	—	8,406	2,320
1915 . . .	99	73	9,587	2,505
1916 . . .	1,834	1,041	15,669	4,484
1917 . . .	91	171	14,175	4,317
1918 . . .	131	262	12,731	5,111
1919 . . .	27	46	24,430	11,634
1920 . . .	—	—	39,507	26,029

[1] *Converted from rupees at the rate of Rs.* 15 = £1.

Prior to 1911 the two kinds of oil were not distinguished in the official trade returns. The exports of "cinnamon oil" for the previous years were as follows: 1908, 285 litres; 1909, 12 litres; 1910, 124 litres.

The falling off in the amount of oil shipped during 1917 and 1918 is attributed to shipping difficulties, since the oil finds a ready market in London. The Governor writes of the industry as the most promising in the islands, affording employment for many labourers, both male and female, who

would otherwise have remained idle. It was estimated that the output of leaf oil in the Seychelles amounted to 50,000 litres during 1920. The bark shipped from the Seychelles is described as very thick, mild in flavour and odour, and very cleanly packed in ordinary bagging (H. E. Sindall, *Journ. Indust. and Eng. Chem.*, 1912, p. 590).

Mauritius

Samples of cinnamon bark and leaves grown in Mauritius were sent to the Imperial Institute in 1909. The bark was found to yield 0·8 per cent. of oil apparently of fair quality, and when submitted to brokers was reported to be equal to "fair Seychelles" worth about 1½*d.* per lb. The leaves gave 1·1 per cent. of oil, which is rather low, the usual yield being 1·5 to 2 per cent., but this oil also appeared to be of fair quality. Neither the cultivation of the cinnamon nor the distillation of its oils seems to have been developed in Mauritius (this BULLETIN, 1910, **8**, 2).

Malaya

A number of trees having been planted near Malacca, a small quantity of quills were prepared in 1851 by Sinhalese convicts, who were professional cinnamon-peelers, and sent to England; but although, considering that the bark was cut at the wrong season and from neglected trees, the report was favourable and the bark was valued at from 1*s.* to 2*s.* 6*d.* per lb., the cultivation was not proceeded with, probably on account of the low prices which have since prevailed (Ridley, *Spices*, p. 222). Various other species of *Cinnamomum* occur in a wild state in the Malay region, some of which, such as *C. tavoyanum*, are akin to *C. Cassia*, the main source of Chinese cassia bark, whilst others, such as *C. Parthenoxylon*, are more allied to *C. Camphora*. *C. Culilawan*, Blume, the clove bark of the Malays (*Kulit*, bark; *lawang*, clove), is a native of both the Peninsula and the islands. Its bark is grey and smooth externally, yellowish-brown within, very aromatic, but so strongly clove-scented as to suggest a high percentage of eugenol. It is collected commercially; and the calyces of the fruit are also used locally in medicine and curries

under the name of "bunga lawang" (clove flowers) (Ridley, *Spices*, p. 236; *Pharmaceutical Museum Report*, 1895–1902, pp. 48, 55).

Fiji

Both *Cinnamomum zeylanicum* and *C. Cassia* have been successfully grown from seed, and the bark and leaves distilled on a small experimental scale at Nasimu in Fiji (*Rept. on Agric., Fiji*, 1911, p. 7). The cinnamon was planted in 1906, and is stated to have become quite naturalised, the seeds being distributed through the forests by pigeons (*loc. cit.*, 1918, p. 6).

The Massoi bark of Fiji and New Guinea, which comes into the Singapore market, is the product of large trees, *Cinnamomum pedatinervium*, Meissn., which Beccari seems to have renamed *Massoia aromatica*. It is thick, grey and hard, with needle-shaped crystals of calcium oxalate, as in the cinnamons and Chinese cassia, and is very aromatic (see page 325).

Africa

Cinnamon has been grown experimentally at the Tarquah Agricultural Station in the Gold Coast, and some of the bark was submitted to the Imperial Institute for report in 1917. It was found not to have so delicate an aroma as that of Ceylon bark and to have a poor flavour; but the yield of oil was about half as much again as from Ceylon bark, and the oil was estimated to contain 68 per cent. of aldehydes. The bark was valued at 1*s*. per lb. and the oil at 5*s*. per oz. in London. Three samples sent subsequently from the Assuantsi, Coomassie and Aburi Stations were of similar rough appearance and general character, but gave equally good results on distillation, averaging 1·8 per cent. of oil, with from 61 to 70 per cent. of aldehyde, as against the requirement of 55 to 65 per cent. for Ceylon oil according to the British Pharmacopœia (this BULLETIN, 1918, **16**, 146; 1919, **17**, 189).

Cinnamon is grown for local consumption in Zanzibar (*Col. Repts., Ann.*, No. 973, 1917, p. 5), and it has been grown experimentally in the Botanic Garden at Entebbe in Uganda.

West Indies

Cinnamon, together with the mango and other useful plants, was found by Captain Marshall, of *H.M.S. Flora* (one of Rodney's squadron), on board a French ship, bound from Bourbon to St. Domingo, which was captured in June, 1782. It was sent to Mr. Hinton East's garden at Gordon Town, Jamaica (*Bull. Dept. Agric., Jamaica*, 1910, **1**, 183), and has since been grown in the island, but not on any considerable scale.

A bark frequently known in the drug trade as "wild or white cinnamon," which is brought to Europe in the form of long quills, rather thicker than those of Ceylon cinnamon, is that of *Canella alba*, a tree in no way related to the true cinnamon. It is a native of Florida and the West Indies, and has been known as "Jamaica Winter's Bark" and "Jamaica Cassia lignea," but is now shipped mainly from New Providence in the Bahamas under the names of "White Wood Bark" or "Cinnamon Bark." It is hot, bitter and aromatic, somewhat resembling a mixture of cloves and cinnamon in taste, and has an agreeable cinnamon-like odour. It is employed as a condiment by the negroes, and is sometimes used in Europe as an aromatic stimulant.

Production of Cinnamon and Allied Barks in Foreign Countries

True cinnamon (*C. zeylanicum*) is grown to some extent in the Dutch East Indies and in Brazil, but the barks produced in foreign countries are in the main derived from other species of *Cinnamomum.*

China

It is highly probable, as suggested by Perrot and Eberhardt (*Bull. Sci. Pharmacol.*, 1909), that there is only one species of *Cinnamomum* which is utilised in China and Indo-China, viz. *C. obtusifolium*, Nees, of which *C. Cassia*, Blume (unknown in a wild state), and *C. Loureirii*, Nees, are only varieties. It seems to be wild in the mountains of Kwantung, Kwangsi, Annam, Laos, and, according to the *Flora of British India*, from Nepal to the Andaman

Islands, reaching altitudes of 7,000 ft., and *C. Loureirii* or *C. pseudo-Loureirii*, Hayata, of Formosa, is believed to be also the source of Japanese cinnamon. It is rather larger than *C. zeylanicum* with more oblong obtuse leaves with short thick stalks, blunt lobes to the perianth and a fruit smaller than that of the Ceylon species. The flowers are mostly pollinated by flies, and the seed is dispersed by birds which swallow the pulpy black fruit as soon as it is ripe. These fruits when dried before maturity are the "cassia buds" of commerce, known in India as Kálá Nágkesar. The bark has been known as a spice from the earliest times, in Western Europe from the seventh century and in England from the tenth, and the tree has been cultivated in the southernmost provinces of China "from time immemorial." The best Chinese cassia is said to be produced from cultivated trees in the neighbourhood of Taiwu in Kwangsi, about 180 miles west of Canton, an extensive plantation also existing near Loting in Kwangtung, and others near Lukpo in the same province. *Cinnamomum Burmanni*, Blume, occurs wild to a small extent in the cassia-growing districts; but does not appear to be either cultivated or barked.

Cassia is grown in forest soil on artificially terraced hill-sides at altitudes of from 300 to 1,000 ft., the first cut of bark being obtained when the trees are about six years old. A few trees are left uncut until ten years old or more, to provide the "buds" and seed. The bark is cut between March and May, the natives stating that after the latter month it loses its aroma. Branches about an inch thick are cut at a few inches above the ground and stripped of their twigs and leaves. Two longitudinal slits are then made with a large-bladed knife with transverse cuts right round the branch 16 in. apart, and the bark is removed in two pieces by means of a curved horn spatula. The epidermis is removed with a small plane, and the bark is then dried for twenty-four hours before being baled. The bundles are about 18 in. in diameter, and are bound together with rattans. The leaves are sent to Canton for distillation (C. Ford and W. T. T. Dyer, *Journ. Linnean Soc., Bot.*, 1884, **20**, 19). The bark is exported, mostly from Kwangsi, through Canton and Hong Kong as "Canton

Cassia lignea " or " Kwangsi cassia "; but Hong Kong also exports a considerable proportion of cassia or " commercial cinnamon " derived from Saigon. Good Chinese cassia bark is sweet and aromatic, closely approximating to Ceylon cinnamon in flavour, though rather less delicate and sometimes slightly astringent. The quills are simple, not inserted one within the other, are less straight, less uniformly thin, and darker in colour than the Ceylon product, and the outer coat is less carefully removed, so that the general appearance is inferior. The tree appears less particular than *C. zeylanicum* as to soil and climate, and its bark might probably be so prepared as to equal Ceylon cinnamon in appearance (H. N. Ridley, *Spices*, p. 229).

It is probably, as suggested by Ford (*Journ. Linn. Soc., Bot., loc. cit.*), from older and larger trees of the same species (*C. Cassia*) that the highly prized thick Chinese cassia bark is obtained, which is known as "Qué kwong" from Thanh-hoa, " Laos cinnamon " or " Royal Cinnamon," and was apparently the unusual " China Cinnamon " described by Flückiger and Hanbury (*Pharmacographia*, ed. i. (1874), p. 477) as having come into London in 1870 in unscraped quills with a very saccharine taste and a pungent cinnamon flavour. Those authors point out that, though agreeing very closely with Ceylon cinnamon in microscopic structure, it differs in that the ring of thick-walled cells (sclerenchyma), which is the outermost layer in ordinary scraped cinnamon, is covered by tissue rich in oil-ducts, " so that it is obvious that the flavour of this drug could not be improved by scraping."

French Indo-China

Writing in 1912 Capus and Bois (*Les Produits Coloniaux*, p. 262) speak of cinnamon culture as tending to disappear entirely from French colonies. In Cayenne, where the bark produced was described by Ridley (*Spices*, p. 222) as thin and long, but pale, acrid and feeble in odour and flavour, it is no longer prepared. Réunion and Martinique are abandoning it. In Indo-China alone is the industry profitable and advancing. The species cultivated in the southern provinces of China is believed

to have been of Annamese origin; but the value and collection of the bark are stated to have been taught to the Annamites and the savage Mois of the mountains by the Chinese in the eighteenth century, and the Chinese pay higher prices for the Annamese barks than for that grown in their own country. Since the Chinese take all the bark they can obtain for use either as a condiment or as a drug, or for export via Hong Kong, there would seem to be no fear of over-production (Capus and Bois, *op. cit.*, p. 265). Annamese "cinnamon" is especially valued in China as a tonic, stimulant and aphrodisiac: no medical prescription is, it is said, made up without it; and it is sold at a great—or in some cases an enormous—profit (Crévost, *Bull. Econ. de l'Indochine*, 1909, **12**, 153). With sugar and tea, cinnamon is one of the principal agricultural exports of Annam; but, in spite of statements to the contrary, the bark is up till now mainly the product of wild trees. Though apparently all the product of a single species, it differs considerably in the various districts, and in quality according to the size and parts of the trees from which it is taken, that of large trees being preferred. The best is that from Thanh-hoa in the north; the second from Nghê-An; and the third from the southern provinces of Quang-Nam—the chief producer—and Quang-Ngai. The general name for the bark is "Qué" or "Khé," apparently the Chinese "Kwei," the three chief qualities being "Qué Kép," derived from trees over 4 in. in diameter, "Qué Kien," from smaller wood, collected when too young, and "Qué Thanh," from branches. Most of the bark is obtained from wild trees; but as these are becoming scarce cultivation is on the increase. The bark from cultivated trees is, however, considered inferior, perhaps because it is usually younger. The Mois, a savage mountain race, clear the lianes and weeds from groups of bird-sown trees in the forest, and have in a few cases planted a score of trees near their villages. The Annamites have a few trees in their gardens in the plains, and there is a plantation of a thousand belonging to a Frenchman in Quang-Ngai. The amount produced in Thanh-hoa is small; but as it sells at 15 to 20 times the price of that from the southern provinces, *i.e.* at more than its weight in gold, the value of the trade is

considerable. The finest having been made a royal monopoly by the court at Hué is known as "Qué Kwong" or "Royal Cinnamon," and a single tree 50 ft. in height may bring in £400 to £600 to the finder (*Journ. d'Agric. Trop.*, 1909, 159). This has also been known as "Laos cinnamon" (*Pharm. Journ.* [4], 1898, **6**, 47). There is some clandestine trade in this bark, which is said to fetch over 800 francs a kilogram (£14 10*s*. per lb.) (Capus and Bois, *Les Produits Coloniaux*); but some "Qué Kwong" from Thanh-hoa sells at Hanoi for 5 piastres a kilogram (about 5*s*. per lb.); and a common quality, "Qué Chi," consisting merely of unpeeled twigs, which are exported to France for distillation in conjunction with Ceylon bark, fetches only 1·25 francs per kilo., (about 6*d*. per lb.). Another quality known as "Qué Tam," resembling Ceylon cinnamon, sells in the same market at 2 piastres per kilo., roughly 2*s*. per lb. In Quang-Nam the price is stated to average 80 francs per kilo. (30*s*. per lb.); but the values as declared for export are far less than these actual prices which are paid by the Chinese (*Bull. Econ. de l'Indochine*, 1909, **12**, 150). Some of the cassia from Thanh-hoa is exported from Haifong; but most of that from the south-west of Faifo in Central Annam is shipped to China from Tourane (*U. S. Commerce Reports, Suppl., Ann. Ser.*, No. 52b, July 24, 1917, p. 4). The whole trade is in the hands of Chinese merchants, the bark being largely prepared by the Annamites, who buy the trees standing from the Mois. Trees ten to twelve years old, averaging 8 to 12 in. in diameter, are preferred, and are generally felled before being barked. The bark is removed in the spring, when the sap is rising, two or three longitudinal incisions being made through the whole thickness of the bark on both stem and branches, followed by transverse circular cuts, so that the bark can be removed by bone or horn spatulas in pieces 12 to 16 in. in length. The strips of bark are bound on pieces of wood, or small cross-pieces of bamboo are inserted, so as to check its curvature in drying, which is held to cause a loss of oil; and the drying is carried out in the native bough-built huts. The bark is cut into squared pieces with bevelled ends, and should have a golden inner surface, its exterior veined with light brown, a fine grain and a polished surface when cut.

Thickness is no sufficient guide as to quality, the bark from the middle of the stem being better than that from the lower portion, although thinner. Outward appearance is the basis of valuation, with special reference to a pad which forms at each end of the stick of cassia between the third and fifth day of drying (V. Cayla, *Journ. d'Agric. Trop.*, 1909, p. 168). The skill of the Annamite worker is, however, devoted to making inferior qualities appear superior by carefully chiselling the rough ends, imitating the grooves in the bark, and staining it with *Rehmannia* to give it the brown colour indicative of richness in oil (Brière, *Bull. Econ. de l'Indochine*, 1904, p. 945). The taste of Annam cassia is said to recall that of coriander. It is unlikely that it would ever realise in Europe the prices it obtains in China. The variety *C. Loureirii*, to which it apparently for the most part belongs, would seem to differ from typical *C. obtusifolium* in having longer and more tapering or lanceolate leaves.

Saigon cassia, which under the name of Saigon cinnamon was official in the *United States Pharmacopœia* of 1894, seems, in spite of Dr. Augustin Henry's reference of it to Annam (*Pharm. Journ.* [4], 1898, **6**, 47), to be partly at least the produce of cultivation in Cochin China. It is made up in bundles 30–40 cm. long, 20 cm. wide and 10 cm. thick, weighing from 1·5 to 2 kilograms each, packed in wooden boxes bound with rattans. The pieces vary in size and colour from small blackish single quills to large thick greyish fragments transversely curved. The material is usually clean, aromatic and of pungent taste, both sweeter and more pungent than ordinary Chinese cassia; but seems to agree with most bark from the south-east in containing a considerable amount of mucilage which is extracted by cold water (H. E. Sindall, *Journ. Indust. and Eng. Chem.*, 1912). Dr. Hartwich (*Archiv der Pharmazie*, 1901) describes this Saigon cassia as distinct in the structure of its bark from *C. Cassia*, though the characters that he gives are so near to those of that species as to suggest that it may be only a geographical variety. It is considered superior to Chinese cassia. Some of the cassia from Cochin China is derived from *C. Tamala*.

Dutch East Indies

Cinnamon barks, as the following table of amounts and values shows, have been a fairly important product of Padang, Java and Macassar.

Exports of Cinnamon Barks from the Netherlands East Indies.

Year.	Padang. (*metric tons.*)	Java. (*metric tons.*)	Macassar. (*metric tons.*)	Total. (*metric tons.*)	Value. £
1908 . . .	673	69	10	752	22,916
1909 . . .	883	69	64	1,016	32,833
1910 . . .	1,071	147	79	1,297	37,333
1911 . . .	744	112	166	1,022	22,250
1912 . . .	921	84	27	1,032	23,666

The cultivation of *Cinnamomum zeylanicum* was introduced into Java in 1825, and, during the existence of a strict monopoly or of high duties in Ceylon, *i.e.* until 1853, the industry was forced by the Government as if to oust the Ceylon product. It was, however, not very profitable, the Ceylon species being said to lose the superior quality of its bark when transplanted to another country, and from 1865, when its cultivation ceased to be compulsory, it gradually died out, and is now grown only on a small scale on a few European estates. A trifling quantity of bark is derived in Java from *C. Cassia* and the rest from *C. Burmanni*; but it is impossible so far as Java is concerned to ascertain what proportions of the whole export of bark is derived from each species. *C. Burmanni*, Blume, is wild throughout the Malay archipelago, and yields a cinnamon of high value. It is a slender tree growing chiefly in the mountains, and the bark is stated to improve in quality the greater the altitude at which it is grown. All the cinnamon bark from Padang, Macassar, Sumatra and Timor is said to be derived from this species, as is also that grown in the Philippines and shipped from Manila; but some of the cassia bark from the Eastern Archipelago may be from *C. iners*. In the interior of Padang, where cassia is grown on a large scale, the trees are barked when about eight years old. The better qualities of bark are from the trunk; the second quality, which is lacking in flavour, being derived from the thicker branches. The bark is scraped, dried, piped and assorted. The United

States has been the chief purchaser of the product of these islands, taking little from Java, but more than half the export from the other islands. Holland takes the bulk of the remainder (*Netherlands East Indies San Francisco Committee Essays*, No. 27, p. 9). Javanese cinnamon is said to rank in value between that of Ceylon and that of Tellicherry. "Batavia Cassia," as it is mainly termed, comes into the market in double quills 5–8 cm. long, nearly smooth and with a dark inner surface with depressed spaces. It is aromatic but very distinctly mucilaginous. "Broken Batavia," which arrives very clean in ordinary bagging, is in considerable demand (H. E. Sindall, *Journ. Indust. and Eng. Chem.*, 1912). The bark known as "Cinnamon Kiamis" is considered by Pfister to be derived from the same species (*Pharmaceutical Museum Report*, 1895–1902, p. 48). M. van Wamerlo (*Indische Mercuur*, March 12, 1907) recommends the planting of *C. Cassia*, by which name he may mean *C. Burmanni*, in West Sumatra in preference to *C. zeylanicum*, on the grounds that the Ceylon species when grown in Java or Sumatra is inferior to the product of Ceylon-grown trees, that the bark of *C. Cassia* nearly approaches that of *C. zeylanicum* in quality and costs less to prepare, and that *C. Cassia* is better adapted to the climatic conditions of Sumatra.

Dr. Pfister also found that the Indian and Malayan barks of *C. Tamala* and *C. Burmanni*, which are known in English commerce as "Cassia vera," are on the Continent termed "Cassia lignea," whilst, *vice versâ*, Chinese and Annamese cassia, known with us as "Cassia lignea," is there termed "Cassia vera" (E. M. Holmes, *Perfumery and Ess. Oil Record*, 1916, **7**, 16). Some of the cassia from Cochin China is stated (*loc. cit.*) to be derived from *C. Tamala*; and there is stated (*Journ. Royal Soc. Arts*, 1916, **64**, 818) to be a wild species of cinnamon in Siam which is obtained in some quantity for export; but neither its qualities nor its botanical identity are known.

C. Sintok, Blume, is a large tree occurring both in Java and the Malay Peninsula, and also—it is suggested—in Sumatra. Its bark is thicker than Chinese cassia, and very aromatic; but, though apparently collected and sold in

Java, it is not certain that it constitutes any part of the commercial bark of Sumatra (Ridley, *Spices*, p. 237).

South America

Brazilian cinnamon, said to be derived from introduced *C. zeylanicum*, is very inferior, spongy and nearly scentless (Ridley, *Spices*, p. 222); and that which was produced in French Guiana was also very different from that of Ceylon.

The Cayenne sassafras, Brazilian clove-bark, or bois de rose (*Dicypellium caryophyllatum*, Nees), a tree 50–60 ft. high, attaining 3 ft. or more in diameter, which is plentiful in the Guianas and Brazil, belongs to the same section of the Order Lauraceæ as *Cinnamomum*. Its wood, leaves and bark are fragrant; and the bark, which is reddish and corrugated, yields on distillation an oil strongly resembling clove-oil and probably consisting largely of eugenol. There were in 1910 seven factories for its distillation in French Guiana, and the export in that year was 22,000 kilos., of value over 550,000 francs. The yield of essential oil averages 22 lb. per ton. The oil is chiefly used in perfumery at Grasse (*Kew Bulletin*, 1912, p. 243).

Conclusions

It is clear that the best cinnamon is the bark of *Cinnamomum zeylanicum*, cultivated and prepared in Ceylon. The yield of bark per acre is too small to be remunerative as compared with other crops at the prices now obtainable; and the yield of oil from the bark is also too small to pay for its distillation, if sold pure. The quantity of oil may be reduced in the laborious processes of scraping and drying, in which the bark is allowed to contract in a manner that is prevented in the treatment adopted for allied barks in other countries. A certain deterioration has been recorded in the quality of the bark shipped from Ceylon of late years; but it is not clearly made out to what extent this is due to want of care in the cultivation or in the peeling, to the age of the branches used, the altitude at which they have been grown, or temporary climatic causes. It also appears that *C. zeylanicum* cannot be relied on to reproduce in other countries the characters which distinguish it in Ceylon, even under very similar conditions of climate and

soil. Bark, however, grown elsewhere, such as that from the Gold Coast, which has not received the elaborate treatment of the Ceylon product, may produce a good quantity of oil of good quality; but the traditionally approved appearance has a large determining influence on the price at present obtainable in the English market. The bark of other species of *Cinnamomum* when collected from wild trees commands an even higher price than Ceylon cinnamon in some markets, such as Annam cassia in China, and it has been suggested that these species might be improved by cultivation and by better preparation of their bark, and that in some places, such as the Malay islands, they may be better adapted to the climate or soil than *C. zeylanicum.* These barks are, however, never equal to true cinnamon; and, even if capable, perhaps, of replacing it by their cheapness as spice, they cannot well be substituted for it medicinally, whilst as mere sources of cinnamic aldehyde they would have to compete with that artificially prepared. On the other hand, the leaves are readily collected and distilled for the oil which is very similar to oil of cloves, and is, therefore, in considerable demand for the manufacture of eugenol and vanillin, so that they form a promising article of cultivation in the Seychelles and elsewhere. *Cinnamomum zeylanicum* can certainly be grown in many of the tropical parts of the British Empire; but it is not possible at present to state precisely the conditions necessary for the production of bark of the best quality. Good bark can apparently be produced in the Gold Coast, for example, and, if it were not necessary to prepare it with the appearance of Ceylon bark, might be produced at a moderate cost. In the face of the competition of the barks of Indo-China, and of oils partly or wholly synthetic, cinnamon bark must at present be considered a highly speculative product.

THE COCOA INDUSTRY OF ECUADOR

ECUADOR is one of the three most important cocoa-producing countries, being only surpassed, as regards the quantity produced, by the Gold Coast and Brazil. The cocoa shipped

from Guayaquil, which forms a very large part of the total production of the country, possesses characteristics of strength and aroma which render it of the greatest value for the preparation of cocoa and chocolate, and in consequence it has always commanded a higher price than most other cocoas. The kind known as "Arriba," in particular, has a pleasant and distinctive aromatic flavour which does not appear to be present in cocoa from any other country.

The question of the possibility of cultivating cocoa of the Guayaquil type in British Colonies was raised by the Imperial Institute in 1917, as the result of an enquiry from cocoa manufacturers.

In the first instance a circular letter was sent by the Imperial Institute to the Directors of Agriculture in several Colonies asking whether they could undertake to conduct trials with a view to determining whether cocoa of the Guayaquil type could be produced successfully in the respective countries, and forwarding samples of the "Arriba" and "Machala" varieties of cocoa.

In reply a number of the Agricultural Officers expressed their willingness to carry out trials, and the question then arose as to the best method of obtaining the necessary seed or living plants without sending an officer to Ecuador for the purpose.

The despatch of seeds or fruits from Ecuador to this country offered no prospect of success, as the seeds soon lose their vitality; but it was thought that possibly seed could be successfully transmitted from Ecuador to the West Indies.

In his reply to the Imperial Institute letter, the Imperial Commissioner for Agriculture in Barbados had stated that an application for seed was being made by the Department to the British Consul at Guayaquil, and at the suggestion of the Imperial Institute he kindly promised that, if the seed germinated and plants were raised, arrangements would be made to distribute a supply to the Gold Coast, Ceylon and other countries for trial.

Unfortunately considerable difficulty was experienced in obtaining the seed. The first supply of pods forwarded from Guayaquil in 1918 reached the West Indies in a rotten condition, and the seeds were dead. Application had there-

fore to be made for a further consignment. In September 1918 the Commissioner informed the Imperial Institute that the British Consul at Guayaquil had been unable to forward a further supply of pods, as the last lot he had received were unfit to send, but that further efforts would be made. So far, however, nothing appears to have materialised in this direction.

The Imperial Institute had been in communication on this subject with Mr. W. S. D. Tudhope, Director of Agriculture, Gold Coast, and during a period of leave in this country in 1920 he went carefully into the question. With the approval of the Secretary of State for the Colonies, he paid a short visit to Ecuador in order to study the problem at first hand. A small consignment of "Arriba" cocoa seeds was specially prepared and forwarded to the Gold Coast for trial cultivation; but, on arrival in the Colony, none of the seeds germinated. The time occupied in transit was eighty-one days, which would seem to be far too long a period for the attainment of satisfactory results, no matter how the seeds were packed.

A copy of the report which Mr. Tudhope made on the results of his journey has been furnished to the Imperial Institute, and the principal part is given, in a slightly modified form, in the following pages.

Mr. Tudhope's object was specially to study the finer qualities of cocoa produced in Ecuador, and, as his visit was somewhat brief, after discussion of the various features of special interest with the several parties directly interested in Guayaquil, from which port all the "Arriba" and most of the other cocoa is exported, several plantations in the Los Rios Province, where the "Arriba" is produced, were visited, and the general methods of cultivation and preparation studied.

"Arriba" Cocoa District

The Republic of Ecuador is reported to contain over 270,000 square miles, and it is all situated within five degrees of the tropical meridian. Only a portion of the country, however, is truly tropical, the greater portion consisting of mountain uplands where the climate is cool and the vegetation that of a temperate climate. Cocoa, therefore, can only

be grown in the low country; its cultivation, however, is spread over a wide area. The "Arriba" cocoa for which this country is famed is all produced in the Province of Los Rios, or the Province of the Rivers—Arriba meaning "above," indicating the more or less elevated nature of the locality. The elevation of the bulk of the cocoa plantations, however, is not more than a few hundred feet above sea-level.

The production of this Province, or of "Arriba" cocoa, constitutes over 50 per cent. of the total export of cocoa. Other parts of the country produce grades known to the trade as "Machala," "Balao," "Manabi" or "Bahia," and "Esmiraldas," names synonymous with the district in which they are produced or the port from which they are shipped.

The time at Mr. Tudhope's disposal did not permit him to visit the other districts, so he was unable to make any comparison with the soil or other conditions that may favour the production of the better quality of the Los Rios product. He was informed, however, that it is the same variety of tree that is grown for the most part in all the different districts and that it is believed that the superiority is due entirely to the soil. The fact, however, that the aromatic quality is understood to vary according to the season in which the cocoa ripens indicates that other conditions also have to be taken into account.

It is possible that Ecuador may be the original habitat of the cocoa tree. At least it is averred that at the conquest of the country by the Spaniards, cocoa was then being grown and made use of as a food by the "Cacha" tribe of Indians who inhabited these parts, and that, in clearing jungle, trees may still be found growing in a state indicating that they are indigenous. The early Spanish colonists began to develop cocoa plantations, and some still exist which are known to have been planted considerably over 100 years ago.

Rainfall and Climate

Mr. Tudhope was unable to obtain reliable rainfall statistics for the "Arriba" district, but he was informed that from May to October very little rain falls. In other

respects, however, the climate appears to be very similar to that experienced on the Gold Coast; the amount of water retained by the soil may, however, be in favour of Ecuador. The rainfall of the other cocoa districts is said to be very much heavier than that of the "Arriba" district, and frequently great difficulty is experienced in getting suitable weather for sun-drying the cocoa. A system of meteorological stations has, however, recently been installed throughout the different districts and more information on this point should soon be forthcoming.

Plantation System

The bulk of the cocoa is produced on large plantations, a few of which contain several million trees and yield over 1,000 tons of cocoa annually. Several of these plantations are held by wealthy local families, some of whom are non-resident, and their management is entrusted to an agent; while others, again, are held and managed by the owner in residence.

The Gold Coast system of individual peasant proprietorship would hardly appear to exist. The plantations seem to have been developed on an old feudal system, and the descendants of the indigenous population are recognised as the servants of the owners of the soil. Indeed, it is understood to be the custom that, when an estate changes hands, the peons, or labourers, on that estate are obliged to transfer their allegiance to the new owner.

So far as the actual management of the plantations is concerned, the Gold Coast has little to learn from Ecuador. They do not bear comparison with European plantations visited by Mr. Tudhope in Ceylon, or with the similar European plantations in the West Indies. Like the Gold Coast farmers, the energies of the owners or management are chiefly bent on collecting the fruits that nature provides, and only a minimum of attention is given to the sanitation of plantations or the pruning of the trees. The soil appears abnormally rich, of an alluvial nature and of great depth, being in this respect undoubtedly much better than the majority of Gold Coast cocoa lands. The trees grow to a great height and attain an immense girth, trees up to

fifty or even sixty feet high being met with. This upward growth is a result of the conditions under which they are grown. Notwithstanding the richness of the soil, many plantations may be found where the trees are not more than ten feet apart, and, as the tendency is to encourage the development of offshoots or suckers from the base, the result is a maze of intertwining branches overhead, locally described as a "gallinero," meaning poultry perches. It is impossible under such conditions for the trees to give heavy yields, and it was not surprising to learn that the average yield is rarely more than 1 lb. per tree.

That the owners or management realise some of their mistakes and are now taking steps to remedy defects and to encourage the teaching of science regarding sanitation are already apparent in the appointment of Mr. J. B. Rorer, from the Trinidad Department of Agriculture, to advise them and to form a Scientific Department, no such institution having previously been in existence in Ecuador in connection with agriculture; the outbreak of the serious disease of cocoa known as "Monilia" has hastened this desirable innovation.

Cultivation and Sanitation

The plantations are usually only cleaned twice a year, and the trees exhibit every evidence of the careless methods of hacking or pruning all too common in the Gold Coast. The gathering of the fruits, however, appears to receive regular attention. There is evidence of the prevalent cocoa diseases known in other countries, especially brown pod or Phytophthora; the farmers, however, contend that it only causes serious loss in very rainy seasons.

About 1914 a new and very destructive disease of the fruits first made its appearance, which is causing great consternation amongst the cocoa growers. The appearance of the fruits may be quite healthy, yet, when broken open, the beans or seeds are found quite useless owing to the presence of this fungoid disease. It has caused enormous losses on many plantations, but Mr. Rorer, who has investigated the disease, seems to think that it can be controlled if frequent spraying of the plantations with a suitable

fungicide and ordinary up-to-date hygienic methods of cultivation are adopted.

Mr. Tudhope states that it is one of the most virulent and subtle forms of cocoa disease that has yet come to his notice. The planters, however, are an intelligent class of men and realise the seriousness of the disease, and, when they understand the action necessary to keep it in subjection, no doubt they will put it into execution. In the Gold Coast it would be much more difficult to stir up the more numerous peasant cocoa farmers to take concerted action to fight any virulent form of disease, such as this, should it ever make its appearance.

Variety of Cocoa

The variety of cocoa grown is almost exclusively that known as "Cacao Nacional." It has been described by other writers as Forestero and typical Amelonado. The fruit is yellow in colour when ripe, and is very similar in colour and shape to the variety so extensively cultivated in the Gold Coast, the ridges are a little more pronounced and the surface is slightly more warty than in the African variety. Further, the pods are decidedly larger, and seem each to contain more beans or seeds of a decidedly bolder and rounder type. One pod that was selected weighed 3½ lb. and the seed contents of a number of pods ranged from forty to fifty-one, with an average per pod of forty-four. In Mr. Tudhope's opinion, it is a decidedly superior type, and he was informed that, on an average, seven pods produce 1 lb. of dry cocoa.

The planters of recent years are more inclined to plant Venezuelan varieties, both red and yellow, with a longer pointed pod, as they aver that they come earlier to maturity and give a heavier yield; but whether they are well advised in this remains to be seen. Mr. Tudhope understands that the Monilia disease is much more rife in the Venezuelan varieties than in the "Cacao Nacional"; and he was unable to ascertain whether the desirable aroma is obtained with the newer varieties—a matter of perhaps considerable importance to the Ecuador planter in the future. It may also be found that the seemingly larger yields are due to

the more favourable conditions under which the trees are now planted, as well as to the younger age of the trees. It is, however, stated that the Venezuelan varieties do not grow so tall and big as the Cacao Nacional, and are preferred on that account.

Harvesting and Preparation of Crop

The gathering of the crop, as already stated, receives regular attention, and this is a point to which the planters give special consideration, as they realise that if the pods get over-ripe the quality of the product is adversely affected. Primitive methods of preparing the beans are still adopted, and practically all the cocoa exported from Ecuador is merely dried in the sun. The pods are cut from the trees, collected in small heaps in the plantation, the seeds extracted and packed in sacks, slung over mules' backs, and conveyed to the Hacienda, where they are at once spread on the drying place—a specially prepared and slightly elevated floor made with sand, over which laced split bamboos are laid to keep the beans from coming in contact with the earth. After sundown the beans are heaped in ridges, over which a shelter is put to protect them from the elements. They are spread out next morning again, and the same process is repeated every day until they are thoroughly dry, when they are bagged for sale.

In ordinary good weather it usually takes only seven days from the gathering of the fruits until the product is ready for the market.

It is understood that a few of the more enterprising planters have introduced machinery for the artificial drying of the beans but that the product has not been well received on the market, and that this is likely to discourage development of the practice. It is just possible, however, that the more rapid drying of the cocoa by artificial means produces an entirely unfermented product, preventing, as it must do, the slight sweating or fermentation which takes place with the heaping practised during the slower sun-drying method, and which is obviously so desirable, and Mr. Tudhope considers that were the beans given only a slight fermentation in mass before drying was resorted to more satisfactory results might be expected.

It is evident that only a very light fermentation is necessary to produce the desirable chocolate break in the dried bean, and it appears that sufficient is obtained by the usual practice of "heaping" during the drying process. Indeed, Mr. Tudhope was informed that if the drying is unduly prolonged by dull weather a condition similar to over-fermentation is brought about, resulting in discoloration of the testa of the beans in the form of little brown or black spots, a condition often present if the pods are over-ripe before they are gathered or if they are left in heaps some time before breaking, despite suitable weather conditions for sun-drying.

Although drying of the cocoa is carried out at once, as above described, it is not true to say that there is no fermentation. It is evident that quite a different seed is being dealt with here from that in the Gold Coast, where six days' fermentation in sweating boxes is necessary before even sun-drying is resorted to, in order to produce a similar chocolate break in the resulting cocoa bean. One must conclude, therefore, that it is a finer type of cocoa.

The object aimed at by the planter is to turn out a cocoa with the lightest coloured testa possible, as this is the one most appreciated by the trade. It does not follow, however, as it would in the Gold Coast, that this is "unfermented" cocoa; and it is considered that this feature of different cocoas sometimes causes a little confusion commercially.

Mr. Tudhope examined many samples of "Arriba" cocoa, and states that it is usual to find a percentage of slaty beans, indicating absence of fermentation, which can readily be understood from a consideration of the foregoing facts.

In the "Arriba" Province some fruits ripen during every month of the year; there are, however, three recognised crop seasons. The principal, or winter crop, is gathered from February or March to June, the summer crop (usually small) is gathered from July to October, and the Christmas crop from November to January. In the Balao and Machala districts the principal crop is usually gathered in August and September.

Labour

The system that has been most general in planting and bringing plantations into bearing has been the contract system, very similar to that practised in Trinidad and other West Indian Islands. The labourers prepare the land and plant the trees, and are paid a fixed sum per tree when the plantation reaches the productive stage. The payments vary from about 20 to 40 centavos per tree in bearing, the smaller amount being paid when the trees have been closely planted. One hundred centavos has a pre-war value of 2*s.* (now 2*s.* 6*d.*), so the maximum payments made were less than one shilling per tree.

For valuation purposes the local banks now estimate the value of a plantation at an average of about 80 centavos (two shillings) per tree in bearing.

Twenty labourers with fifteen mules are regarded as the average requirements to maintain a plantation of 100,000 bearing trees, and a relatively smaller number than this is kept on some plantations. A labourer is paid about one sucre (2*s.* pre-war, now 2*s.* 6*d.*) per diem, and there is a general complaint of a shortage of labour which would no doubt be much more acute were a more intensive system of cultivation adopted, and already there is a talk of indentured immigration.

Cost of Production

On the present scale of expenditure on plantations it can readily be seen that cocoa is produced very cheaply in Ecuador. Mr. Tudhope was authoritatively informed that the all-in costs to the port of shipment are about eight sucres (20*s.* at present rate of exchange ; 16*s.* pre-war) per quintal (100 lb.). The price of cocoa during his visit was 42·50 sucres per quintal in Guayaquil—a price, however, that has been rarely exceeded and is much higher than the average price that may be expected in normal years ; nevertheless, there is a wide margin for fluctuation, which serves to indicate the profitable nature of the industry.

Transport and Marketing

As cocoa is produced in comparatively large individual quantities, there are few difficulties as to marketing and transport, and there is practically no petty buying.

The principal port in Ecuador, and the port from which all the " Arriba " cocoa is exported, is Guayaquil, and here the principal exporting firms are established with their offices and stores that in many ways remind one of Accra. The cocoa is seen here receiving its final drying, and everywhere along the river front the pleasant aroma of cocoa is noticed.

The " Arriba " country is well served by the river Guayas and its tributaries, most of which are navigable to small river craft, and all the cocoa arriving at Guayaquil is water-borne.

The larger plantations usually maintain their own barges or motor-launches, and private individuals or firms undertake this work for others on contract.

The cocoa is usually sold by sample in much the same way as grain and other produce is offered for sale on the markets or exchanges in England, and the producers, or persons selling on commission—a not uncommon practice—may try all the various firms and sell to the highest bidder, the cocoa being thereafter delivered at the factory. The cocoa is bought and sold on a unit of one quintal (100 lb.).

The exporters maintain gangs of labourers for handling the cocoa, including re-sunning where necessary and bagging it into their own sacks ready for shipment. It is shipped in bags containing 175 lb. net, and the lighterage is all done by the Government, after the bags are placed in their barges, for which a uniform charge of 12 centavos per quintal (about 6*s*. 9*d*. per ton) is made.

Associacion de Agricultores, and Control of Prices

The Associacion de Agricultores del Ecuador comprises nominally all the producers and possibly also all the exporters of cocoa. It was formed in 1913, and has for its main object the defence of the industry against the speculations of foreigners unduly lowering the price of the local product. It has a president, a vice-president, and a number

of directors, appointed by ballot of the members, who control its operations; and it has a regular staff of officers and foreign agencies. It is officially sanctioned by the local Government, and is empowered by legislation to collect an export tax to finance its operations on all cocoa exported from the country. When the Association was formed the tax was fixed for the first year at one sucre per quintal, and it has been subsequently increased and the tax for 1920 was as much as three sucres, equivalent to 7*s.* 6*d.* (present value) on every quintal (100 lb.) of cocoa. As the annual production of cocoa is now approximately 1,000,000 quintals, this represents a revenue of over £300,000.

This Association not only fixes a price at which the cocoa may be bought locally after consulting their various agencies, but also buys cocoa at the prices fixed and ships it on its own account. In this way it is understood that about one-half of the cocoa produced in the country is now actually handled by the Association.

The intervention of the great world war, so soon after the inception of the Association, no doubt to some extent interfered with its operations, and naturally the Association is criticised by the private trading firms; but it is obvious that through the crisis and dislocation of trade brought about by the war it proved a bulwark of strength to the cocoa industry and kept up the price to the local producers far beyond that which they would have obtained had it not been operating. It is understood, however, that its credit was taxed to such an extent at one time that, had the war not ended as and when it did, a severe financial panic affecting the whole State might have occurred. It was able to weather the storm, however, and under efficient guiding may now be said to be a popular innovation.

Primarily started to regulate the trade in cocoa, its operations have been extended to include the diseases affecting the plantations, and it was under its auspices that Mr. Rorer was asked to investigate the serious outbreak of Monilia disease already referred to, and was subsequently appointed to institute a scientific department. It is believed, therefore, to be only a matter of time until all the various agricultural activities of the Republic will be supervised by it.

Export Taxes on Cocoa

At the present time cocoa bears the following export taxes in Ecuador: (i) The tax of three sucres per quintal imposed by the Association of Agriculture, which is for all practical purposes a Government Department; (ii) a direct Government tax of 6¼ centavos per kilogramme; (iii) a municipal tax of 1½ centavos per kilogramme; and (iv) a further overhead Government tax of 40 centavos per 100 kilogrammes.

Reduced to English currency at the present rate of exchange (1 \$ = 2*s.* 6*d.*) the following shows the approximate rates of taxation on every 100 lb. exported:

	£	s.	d.
1. Association Tax	0	7	6
2. Direct Government Tax	0	7	1
3. Municipal Tax.	0	1	8
4. Government Overhead Tax	0	0	5
	£0	16	8

Conclusion

The conditions under which cocoa is produced in Ecuador are vastly different from those on the Gold Coast, and, as already stated, speaking generally, Ecuador has not much to teach that Colony in the management of the plantations. The superior quality of their "Arriba" cocoa appears to have come to them more by chance than guidance; whether it may be a result of soil conditions or not, Mr. Tudhope is not prepared as yet to say, although evidence collected seems to support this contention strongly; but he is satisfied that the "Nacional" variety of cocoa is a variety with several desirable qualities, and one well worth experimenting with elsewhere.

CULTIVATION OF PARA RUBBER IN INDO-CHINA

M. AUG. CHEVALIER was commissioned by the French Government in 1913 to investigate the position of the chief crops of Indo-China. He paid special attention to the

rubber plantations there, and at the Rubber Exhibition held in London in June 1921, he contributed a paper setting forth the results of his observations and his views on the possibilities of the rubber-growing industry in that country. A copy of his paper, entitled, "La Culture de l'Hévéa en Indochine et son Avenir," has been kindly placed by him at the disposal of the Imperial Institute, and a summary of its contents is given in the following pages.

Extent of Rubber Cultivation in Indo-China

The efforts to cultivate *Hevea* (the Para rubber tree) in Indo-China are on a much more modest scale and of more recent date than those in Malaya or Ceylon, or even in Java, Sumatra, Borneo or Southern India, but they deserve notice because they are mostly those of men with no long experience of planting and with only moderate capital, though possessing admirable perseverance. It must, of course, be admitted that the results obtained in Malaya were a great encouragement to these French planters, most of whom learnt their work and obtained the seed for their first nurseries in Singapore. The *Heveas* introduced by Louis Pierre from Calcutta to the Saigon garden had long disappeared, the lateritic soil of the garden being unfavourable to the plant. In 1897 some Ceylon seed was sent by Mr. Raoul, Government Chemist, to M. Haffner, director of the Saigon garden, who forwarded part of it to Dr. Yersin at Nhatrang, and planted the rest partly at the agricultural station at Ong-Yem, near Thudaumot, and partly, at a later date, at Xa-Trach in Cochin China. The plants obtained grew very well. M. William Capus, then Director of Agriculture in Indo-China, encouraged the experiments, and some colonists who had previously preferred *Ficus elastica* decided to plant small areas of *Hevea*. A small series of Para trees planted by a M. Bellan in the environs of Saigon in 1900 began to yield in 1906; and in the same year the Agricultural Department of Cochin China sent to the Colonial Exhibition at Marseilles the first specimens of rubber prepared at the Ong-Yem Station.

The first plantations of any importance were begun in

1907 at Xa-Trach and Suzannah: the boom of 1909 stimulated the industry; and in 1910 1,140,000 trees were planted out by companies or private owners. In 1914 the area planted in Cochin China was estimated at 14,174 hectares, and the capital invested at about thirty million francs, whilst to-day it is about forty million francs. At the end of 1917 there were 21,300 hectares planted, representing 6,300,000 trees, and in 1919 about 26,000 hectares. In 1920 5,000,000 *Hevea* trees were ready for tapping, but, on account of the slump in the rubber industry, the tapping of trees five to six years old was postponed. The production has been approximately as follows:

1910	10 tons	1917	900 tons	1919	2,936 tons
1916	544 "	1918	1,500 "	1920	3,601 "

It is estimated that a six-year-old plantation can give 125 kilograms of rubber to the hectare, and one, eleven to twelve years old, 500–600 kilograms. Between the ages of twelve and fifteen years the best managed plantations can reach a yield of 800 kilograms per hectare. By 1925 the production should therefore be 12,000 tons a year, and by 1930 16,000 to 20,000 tons, assuming that all existing plantations are preserved, cared for, and rationally tapped.

At the Colonial Agricultural Congress at Paris in 1918, M. Octave Dupuy estimated that 21,322 hectares would be in bearing in 1921, and, reckoning on an average crop of 368 kilograms to the hectare, estimated the production for 1922 at 7,853 tons. The production for the current year will certainly be very far short of this figure; it will hardly exceed 4,000 tons; and when it is considered that France uses 12,000 to 15,000 tons, or, but for the economic crisis following the war, 16,000 tons, and that the French colonies in Africa do not supply more than 2,000–3,000 tons, it will be seen that it will be a long time before the French colonies supply all the rubber needed by the industries of France.

Extensive areas of very good land are still procurable in Cochin China and Cambodia; the Government of Indo-China is very liberal in the terms under which concessions

are granted, and the local labour supply is adequate, easily controlled, intelligent and remarkably apt. A Scientific Institute has been started by M. Sarrant at Saigon; and will soon, it is hoped, be in a position to deal with most of the technical problems which are so often a hindrance to colonial planters.

M. Chevalier would, without hesitation, advise the extension of the existing plantations, if he did not fear such a world's excess of production of rubber as is already making itself felt in the Federated Malay States, Dutch East Indies and Ceylon. It is certain that if the existing crisis is much prolonged, many of the old plantations will succumb, and it is probable that, when the crisis is passed, the surviving plantations will be insufficient to meet the world's consumption, which should reach 600,000 tons in 1925.

Climate and Soil

It was long believed that, to succeed, *Hevea* required a deep soil, rich in humus, constantly saturated or even marshy, and an atmosphere saturated with moisture throughout the year, such as exist in its country of origin. Some few years back, J. Huber stated that Para rubber grew only in the valleys of the Amazon system, being replaced on the intervening hills by other species of *Hevea*. When brought under cultivation in Asia the tree behaved in an unexpected manner. It grew rapidly in marshy lowlands and valleys formerly occupied by virgin forest; but it soon perished or became invaded by parasites if measures were not adopted to drain the soil and admit light and dry air among the trees. East Cochin China presents these necessary conditions naturally. It is a monsoon country, where 500–2,500 mm. (20–100 in.) of rain, varying in different years and localities, falls during the summer south-west monsoon between May and the end of October, and where there is a dry season of about six months, January to March being extremely dry. Though the temperature averages 26° C., the nights in December and January are rather cold, and the water-vapour condenses into a heavy dew. At this period *Hevea* loses its leaves;

but it only remains bare for a week or two at most. Such is the drought during the day at this season that almost all cryptogamic growth is stopped. *Hevea* unquestionably benefits by these conditions. Its growth slackens and it enters on a period of half-repose; but the life of almost all its parasites is completely stopped; and, if the air is allowed to circulate through the plantations, most of the fungoid mycelium will cease to grow.

Most of the plantations are on land between sea-level and 200 metres altitude, and sufficiently drained. All the lowlands are in the west of Cochin China, and are occupied by the rice-fields of the natives. In the east and north-west, on the other hand, the somewhat higher ground, unfit for irrigation, was mainly left unused by the Annamites. Europeans who wish to plant have therefore at their disposal extensive areas which the natives do not use.

The land on which *Hevea* is grown is divided in Cochin China into two categories: (i) grey land, and (ii) red land, of which the former is the less fertile. Some of th grey land consists of alluvium impoverished by deforesta tion or by long cultivation without manuring, and aban doned by the natives. Other grey land is very poor sand arid or covered with useless scrub; but there is also grey land which only requires cultivation and manure to be rendered tolerably fertile. As these lands are near inhabited centres, labour can be readily recruited; being less wooded and less moist than the red land, they may produce *Hevea* less subject to disease; and, but for the loss of a year in coming into bearing, they may give a return of rubber approximating to that from the red land. As the initial cost of this grey land is less, and the cost of establishing plantations on it considerably less, it may even yield a better return than the red land to capita invested. This can, however, only be determined by the results obtained over a series of years. If the less arid parts only are utilised, it is possible to obtain satisfactory returns from *Hevea* on these grey soils, the wild vegetation indicating which parts are suitable for planta tion and which for pasturage only.

The red land is a loess or plateau drift in a volcanic district, always on or near the outcrop of eruptive rocks

It is partly the result of rock decomposition *in situ*, partly of the dispersal of volcanic mud. Generally fertile, these soils apparently owe their fertility rather to their physical than to their chemical characters. Under dry farming they become very porous, absorbing and retaining a very large proportion of water, and thus reducing the run-off and the soil-erosion of the rainy season. At the same time, during winter there is a considerable shifting of the surface soil on red land where there is the least slope, which often means a serious loss of the humus which is so valuable to the roots of cultivated plants. Such soils require, therefore, very thorough cultivation, and will then resist evaporation and retain a water-supply for the roots, even in the height of the dry season. These soils are strong, argillaceous, rich in phosphoric acid and nitrogen, though less so in potash and lime; and, with proper treatment, will grow all the ordinary cultivated crops of the tropics. In addition to rubber, many other crops have been successfully grown on them, including coffee, coconut, tea, tobacco, sugar-cane, camphor, kola-nut, oil-palm, maize, mountain rice, ramie, indigo, cotton, sisal, and bananas.

Almost all the red land of Cochin China is to-day already taken up with *Hevea*; but there are millions of hectares available in Cambodia and Southern Annam. Left to itself this land becomes covered with tall, moist and malarial forest, the clearing and cultivation of which is more difficult than that of the non-wooded grey land.

Maintenance and Manuring

The colonists of Indo-China long ago learnt the falsity of the popular notion that tropical soils are exceptionally fertile, and respond without trouble to every kind of cultivation. It is recognised to-day that tropical lands require as much care in management as do those of Europe, and in no country has this principle been made clearer than in Cochin China and Tonkin. In planting *Hevea* Cochin China may be said to have tried every method of cultivation. At Loc-ninh it was at first thought sufficient, as in Malaysia, to cut the large trees to the ground level, to grub up the brushwood, burn it on the spot and

plant the *Hevea*, without removing the stumps. This method answered on ground covered with bamboos, because, after the culms were cut, the clumps (rhizomes) died and made by their decay a very porous soil; but where there are trees the non-removal of the stumps has serious drawbacks. M. Chevalier has seen prosperous plantations with the *Heveas* wide apart on grey land not clean weeded; but in these cases the sandy soil was covered with a short turf made up mainly of a small leguminous plant, *Desmodium triflorum*, the tubercle-covered roots of which fix abundance of nitrogen. Except in this case continuous clean weeding from the formation of the plantation is advocated.

One of the greatest difficulties is the extirpation of the rhizomes of the lalang or tranh grass (*Imperata cylindrica*), which invades fallows almost everywhere in the tropics. In small or medium-sized plantations such weeding is done with the common tools of the country or by imported ox-drawn ploughs. European ploughs were introduced by M. Girard in 1907, and in 1913 a perfect system of tillage was established at Anloc, including the removal and burning of stumps and deep cultivation by means of tractors and large ploughs with several blades or discs. The ground is subsequently cultivated between the rows of trees by lighter tractors and harrows drawn by pairs of oxen, which enables the rubber trees the better to withstand the dry season. Two workings a year, one in each direction, are generally enough, with some hand weeding. For the intensive working of a plantation of about 2,700 hectares in eight months, seventy ploughs, cultivators or harrows and thirty light carts for transport, manure, forage, etc., will be necessary, each taking a pair of oxen. For relays fifty additional oxen and for breeding, replacing, etc., at least another hundred are necessary, making a total of 350 oxen, whilst in practice double the number will be kept. Some plantations have much larger herds, up to 2,000 head, some being sold for meat, others being kept for milk and cheese (as in the Tonkin coffee plantations) and, especially, for the sake of the manure. The Suzannah-Anloc group of plantations, comprising 2,700 hectares planted, maintain 2,200 head of cattle, to feed which there are 400 hectares of artificial pasturage, planted mostly

with Para grass, and 400 hectares of fallow, with native grasses. There are also considerable rice-fields made in clearings in the forest, for the sake of the rice-straw as dry fodder. M. Girard reckons a hectare of well-managed meadow in Cochin China as capable of feeding four head of cattle almost throughout the year; whilst in Tonkin a hectare of fallow per head is considered necessary. M. Lionel-Marie, who has visited the chief agricultural regions of Indo-Malaya, remarks that nowhere in the Dutch East Indies or in the Federated Malay States can plantations be seen so carefully managed as are most of those in Cochin China, and that their progress is due to this maintenance of a large head of live-stock.

In well-managed estates the soil under the rubber trees is kept constantly fine and free from weeds. The latter will disappear when the trees completely shade the ground. Dead leaves are ploughed in as manure; but close to the trees digging is preferable, so as not to damage the roots. This takes less and less labour, so that it often costs less to maintain for a whole year a hectare that has been well cared for than to clear lalang grass out of a tenth of that area.

Soil erosion is sometimes very great during the rainy season on red land where there is any slope; and this is a serious impediment to the increasing of the fertility of the land. The soil should be kept fine, so that the humus may accumulate *in situ*, the ideal being that all rain shall be able to soak in where it falls. It will rise again by the capillarity of the soil in the dry season, bringing with it in solution the elements needed for the nourishment of the rootlets. Some plantations have lately taken steps to level their ground to lessen soil erosion and the exposure of the roots of the *Heveas*.

It is now generally agreed that it is necessary to furnish *Hevea* with fertilising matter, especially where the soil is only mediocre, *i.e.* on most grey land. M. Morange says that it is equally necessary on red land from the time when tapping begins, if production is to be maintained. Farm manure produced on the estate has been shown to be the best both for growth and for latex-yield. The amount to use depends on the richness or poverty of the

land and must be first determined by an analysis of the soil. Where herds are not kept, manure or vegetable by-products, such as poonac, ground-nut or castor cake, the dregs from distilleries, or the husks and offal of rice, are bought from the natives. On siliceous soils it is well to use lime or wood-ashes as additional manure for *Hevea*. Some plantations have begun to use chemical manures such as the natural phosphates of Tonkin, and imported superphosphate, basic slag and potassium salts. Quite recently some experiments have been made with Alsatian potash and powdered cyanamide ; but it is too soon to pronounce on the effect of these manures on the yield of rubber.

Diseases

Though, on account of the long dry season, *Hevea* suffers little from fungoid disease in Cochin China, it has to be carefully watched on some of the red land. The most serious diseases are pink-disease (*Corticium salmonicolor*), die-back (*Botryodiplodia Theobromæ*), and claret-coloured canker (*Phytophthora Faberi*), which arises when the cambium-layer is injured in tapping. It is important not to tap healthy trees with uncleaned knives which have been used on contaminated trees. M. F. Vincens, a plant-pathologist, has been attached to the Scientific Institute at Saigon to give planters that technical advice which is so indispensable. Up to the present the losses due to disease in Cochin China have been insignificant.

Methods of Working

When the price of rubber was high, it became usual to tap trees 4½ years old. With the fall of price, 5 or 6 years became more general. Some planters recommend waiting till the seventh year to allow more bark to form. M. O. Dupuy estimates the annual increase in girth of *Hevea* in manured grey land to be one decimetre at a metre from the ground, and on red land 14 centimetres.

Planters are not agreed as to the spacing of the trees. The first plantations were at 5 × 5 metres, and 4 × 8 metres. A good many later adopted 5 × 6 metres and the tendency at present is towards greater distances, 7 × 7 metres, or

even 10 × 10 metres. Most planters favour close planting with gradual thinning, only the most laticiferous trees being retained. The plantation thus ends by being very irregular; but there is usually retained an average of 200 trees per hectare (80 per acre).

The systems of tapping have been much varied for some years, and the present tendency is towards the greatest possible economising of the bark, not more than one or two cuts being made, involving a third, a quarter or a fifth of the circumference of the tree; while the daily paring is not more than a millimetre thick. The bark has an average thickness of 0·008 to 0·010 metre and about 0·002 metre of the bast next to the cambium layer is left untouched. The Annamites, and even the far more primitive Moi, show themselves very able tappers.

In 1917 M. Girard began a series of experiments on alternation of tapping with a view to economising the *Heveas* for the future. The first trial was an annual alternation—tapping, that is, half the trees in a plantation one year and leaving them untapped during the following year. He then tried alternate day tapping as advocated by Mr. S. Morgan in 1912, and finally a monthly alternation. By the method practised in his plantation of resting the trees every other month, tapping is carried on for 150 days or more in the year and periods of rest are spread over the whole year. In this system an annual strip 0·18 metre wide is removed from a third of the tree, and an economy of half the cost of labour and superintendence is effected. Nor, according to M. Girard, is the saving on the care of trees diseased as the result of daily tapping less considerable, whilst, with the low price of rubber, the economy of bark —which is, in fact, the rubber grower's capital—is of even greater interest. It is admitted that, if generally adopted, the system of alternation might entail a loss of 40 per cent. of the production during the first year, and 15–20 per cent. in the second; but the diminution would then be replaced by an increase, while the life of the plantation would be greatly prolonged.[1]

[1] M. Girard has sent M. Chevalier an unpublished note on this subject which is here printed: "The results of the experiments begun in 1917, which have been precisely recorded day by day, completely confirm our forecasts,

A diametrically opposite opinion has been expressed by some planters, who believe that it is unnecessary so to consider the future, but that it is only needful to obtain the greatest possible yield in the shortest possible time, following the example of the Chinese and Japanese, who plant 150 trees to the acre, take very little care of them, leaving them to be attacked by disease, collecting the latex as soon as possible, and letting the trees perish when they have made sufficient money out of them. M. Ed. de Wildeman even questions whether it would not be better to tap the trees to death, making arrangements to have a succession of new ones and to have fresh land to exploit.

In M. Chevalier's opinion such a proposition is indefensible. It is true that on virgin land some crops will give good results in the first generation, even with little care. This apparent prosperity is, however, of short duration, and the superiority of careful cultivation will soon be shown by the competition of other countries where painstaking and capital are not spared. This has been the history of the cultivation of the sugar-cane, and many plantations are now doomed to disappear because the soil and even the climate have been deteriorated by a system of cultivation that has been extensive but not intensive. M. Chevalier is firmly convinced that in Indo-China, as in Malaya or Ceylon, the future lies with carefully tended *Hevea* plantations in which the trees are kept as long as possible in health and full bearing. If the trees to fill gaps, or to extend plantations, are selected, a remunerative return will be obtained, as soon as normal trade conditions are restored, when badly kept plantations will no longer be able to stand the competition.

In the sample plot we have collected in the third year double the amount of rubber to the hectare of the first year. Other plots have been tapped in alternate months with two cuts on a fifth of the girth the first year, one cut on a fifth the second year, or one cut on a fifth during both the second and the third years, and have given a yield almost threefold from the same area and more than double for each tapping. A third plot tapped one month in three on a half of the tree in a single V has quadrupled its yield per hectare. . . . In the third year all the plots gave the same yield per hectare, viz. (1) the sample plot with six tappers; (2) the plots with a monthly alternation with three tappers, and (3) the plot with one month's tapping in three with two tappers, each man having thus 9 hectares to tap, the plots consisting of 18 hectares each."

Selection and Grafting

Sometimes trees in the same plantation of the same age and vigour, and treated alike, vary in their yield of rubber as 1 to 4. Such variability occurs in all kinds of crops; and from a remote antiquity civilised peoples of all races have multiplied choice sorts by grafting, budding or cuttings so as to preserve the characteristics of the parent plant. With regard to *Hevea* an immense field of work remains for exploration by the specialist. One of the most urgent undertakings should be the study on the spot of all the species and varieties of *Hevea* in the forests of Brazil, work begun by Spruce, Huber and Ule, but far from being completed. Seeds or young plants of the more practically interesting forms should be sent to a botanical garden chosen for the trials in the East. Such an experiment has been started at Buitenzorg, but on too small a scale. In 1874 only ten species of *Hevea* were described in the *Flora Brasiliensis*; between 1900 and 1912 the Swiss botanist, Huber, the lamented director of the Goldi Museum, Para, discovered ten more; and Hemsley and Ule have added to the list; but these species are very little known. Some of them, such as *H. Benthamiana* and *H. Duckei*, Hub., of the Rio Negro and Rio Japura, and *H. Foxii*, Hub., of Peru, are said to contain as much latex as *H. brasiliensis*. Even the area of distribution of the latter species in a wild state has not been precisely determined, and it has probably numerous geographical races adapted to different conditions of soil and climate. All the seed obtained by Wickham (1876), Poisson (1899) and others was collected on the Amazon, somewhat at haphazard.

In 1907 M. Georges Vernet called attention to the extreme variability of *Hevea brasiliensis* in the East, both in structure and in physiology, the latex varying in its content of caoutchouc from 25 to 40 per cent. That the fall of the leaf, flowering and fruiting do not occur at the same time in different trees is important, since the flow of latex reaches its maximum some weeks before the period of rest and also increases at the time of fruiting, so that the curve of yield has two annual maxima, doubtless under

climatic influence in any particular country. Vernet recommended that seed should be employed only when taken from old trees which have only come late into bearing.

It has been known for ages that seed cannot be depended on to reproduce all the characters of the parent, whilst grafting or budding will generally do so, though it is possible that, after a time, bud variation may eliminate the characters of a graft from some of its branches. Some experiments made by M. Lucien Daniel under M. Chevalier's control at Rennes in 1920 go to show that a grafted plant forms in reality a symbiotic combination of stock and scion. As latex is a solution of various mineral and organic substances in which the globules of caoutchouc are suspended and its formation depends on the activity of both the leaves and the roots, it is probable that in a grafted *Hevea*, where the roots belong to the stock and the leaves to the scion, the yield and quality of the caoutchouc will not necessarily be those of the plant furnishing the scion. The budding of *Hevea*, which is not difficult, has been begun on some plantations in Malaya as a means of directly multiplying good-yielding individuals, or of isolating them to secure self-pollination. Unfortunately there are in the colonies very frequent changes in the personnel, while such observations, to be useful, should be conducted with care during a long term of years. Seed is selected from trees notably resistant to root diseases, and it is recommended that promising young trees should be budded in the nursery when twelve to eighteen months old. Shield budding is found to answer best, the budding being done as near the base of the stem as possible and bands of paraffined cloth being employed, with a thin covering of tepid paraffin over the whole to keep out rain-water. This practice is still in the experimental stage, and budded trees are often less vigorous and less resistant to diseases than those on their own roots.

Coagulation of the Latex

In all plantations coagulation is now effected with acetic acid, and it is no longer disputed that an excess of this acid is deleterious to the rubber. If not added in very large proportions, the sodium bisulphite used to give a white

rubber has no influence on the quality. Buyers, however, do not consider paleness so indispensable a character of good crêpe rubber as they formerly did. Owing to its high price towards the end of the war, acetic acid was in several estates replaced by rice vinegar; but these have now reverted to the acid. Sugar was also experimented with as a coagulant, but abandoned.

It is useful to dilute the latex before coagulation so as to secure a uniform content of rubber throughout.

Quality and Standardising

It is a reproach to Indo-Chinese rubber that it is not uniform, and often leaves something to be desired as to quality. The rubber prepared at the Pasteur Institute at Nhatrang, at Ong-Yem, and on some large estates is excellent; but this is not so with most of the small plantations, which would do well to combine for the preparation of the rubber or even for the coagulation of their latex in joint factories. In this way a uniform quality would be gradually obtained for Indo-Chinese rubber. Purchases are made according to the appearance and not according to the intrinsic quality of the rubber.

Up to the present the soil has not been recognised as influencing the quality of rubber produced in Indo-China, the quality being practically identical from the grey and red lands. On the other hand, it certainly varies in different trees of the same plantation. Morange and Balancie have long maintained that certain trees at Ong-Yem give a brilliantly white crêpe, whatever coagulant is employed, this colour being retained while that of others turns rapidly grey or brown. Experiments are in progress to discover if this property is hereditary.

The composition of latex is undoubtedly dependent on nutrition, which is known to be largely influenced by meteorological fluctuations; and it is probable that in time it will be proved that there are certain seasons when it is best to cease tapping.

Yield

The yield from plantations of the same age varies considerably according to the spacing of the trees, the care

given to them, and their early treatment. The amount of latex taken in the early years appears to have often been excessive, and, where the bark has been much injured, several years' rest ought often to have been given. M. E. de Wildeman recommends a reduction in the number and in the length of the incisions, so as to reduce the average yield from mature trees from 400 lb. per acre to 300 lb. (about 336 kilograms per hectare). This figure appears too high, since, according to M. Girard, plantations made between 1910 and 1913, *i.e.* 8–12 years old, do not on the average (young, old, good and bad) give more than 285 kilograms per hectare (about 251 lb. per acre). M. Girard proposes to limit the depth rather than the area of tapping, and states that with a monthly alternation he has thus avoided all deformation and diseases of the bark. It would seem that in Cochin China the average yield with daily tapping should approach the following figures :

Age. *Years.*	Yield. *Kilos. per hectare.*	Age. *Years.*	Yield. *Kilos. per hectare.*
6	125	10	430–450
7	200	11	500–550
8	175–290	12	600–670
9	300–363		

Avenue trees at Ong-Yem have given over 1,000 kilograms, but this is altogether exceptional. The Belland plantation near Saigon, 18–20 years old, has given 600–800 kilograms per hectare.

Nothing can yet be said as to the condition of old trees tapped indefinitely in plantations. In Malaya some are dead from neglect or overcrowding, some, perhaps, from diseases or from too intense working. *Hevea* is a tropical forest species with relatively soft wood and rapid growth, so that its longevity is not likely to be very great, and trees a hundred years old are probably rare in the Brazilian forests. Probably healthy trees reach their maximum yield at 30–40 years of age. Dr. O. de Vries has recently made some observations as to the quality of the latex obtained from old trees, and finds that its content of caoutchouc is very high, that it is of better viscosity, and takes less time to vulcanise.

Economic Considerations

The area available for the cultivation of *Hevea* in the south of Indo-China is all but illimitable. In the red lands there is not, apart from forest reserves, a great deal of cultivable land to be conceded ; but in Cambodia there are more than a million hectares of this soil in the less accessible parts where, however, roads will shortly be constructed. This land lends itself to the cultivation not only of *Hevea*, but also of coconut, coffee, tea, sisal and cotton.

The terms as to concessions are much more liberal than those in the Federated Malay States or in Sumatra. A request for a concession is followed by an administrative enquiry, costing one-fifth of a dollar per hectare. The land has then to be measured and delimited at the expense of the concessionaire. The first 300 hectares are granted free, further areas being put up to auction and seldom fetching more than two dollars per hectare, but often less. If, after five years, the concessionaire has begun to work half his grant, he becomes full proprietor of the whole.

The land is exempt from taxation for six years from the concession or purchase : from the seventh to the tenth year it increases gradually to 1·6 dollars a hectare ; and from the eleventh year onwards it is two dollars per hectare per annum. Unplanted land pays three-fifths of a dollar per hectare after the seventh year.

Labour is sometimes obtainable locally, the grey land being in the inhabited zone ; sometimes it is obtained from Tonkin and North Annam ; or coolies are recruited under contract. Few planters employ Chinese. The cost of recruiting and transport from Tonkin and Annam is about 40 dollars, and the rate of wages two-fifths of a dollar a day for a man and three-tenths for a woman. A coolie under contract receives about 170 dollars a year, or an average of $0·52 per working day. In the most populous parts, such as the environs of Saigon, labourers are engaged on the spot at about 100 dollars a year and women are paid one-fifth of a dollar a day. Annamite labour is at least as skilful as Tamil, Malay or Javanese, and more easy to handle.

The rise in the rate of exchange has been a serious hindrance to the development and extension of plantations during recent years, compelling planters to reduce the amount of labour on upkeep as far as possible. The Indo-Chinese piastre which, before the war, was normally at 2 fr. 50, reached, between June 1919 and June 1920 a maximum of 17 francs and an average of 10 fr. 40. Though it has fallen, it still stands at about 6 francs, which, as the coolie is paid in piastres, constitutes a heavy burden on the planter. The low price of Annamite labour, which before the war was one of the most favourable factors in the extension of plantations, has ceased to exist from 1917–18. The crisis was at its worst in 1919–20 and it is hoped that it will soon disappear. Since 1919 a bounty on export, based on the production per hectare according to the age of the trees, has rendered effective aid to the planters, each kilogram benefiting by about a tenth of a dollar.

The net cost of production cannot, on account of this variable rate of exchange, be stated in European currency. The Saigon Planters' Syndicate put it at \$1·20 per kilo.; but this includes interest on capital. Some planters on grey land put it at \$0·30—0·40, without interest; and on red land at \$0·60—1·0. Net cost must always vary chiefly according to the amount produced, which again varies with the age of the trees, the intensity of tapping, and other conditions.

Conclusions

There are now 1,234,000 hectares under *Hevea* in the world, which should give 415,000 tons of rubber by 1925, taking the yield at 300 lb. per acre. The average production in the Malay Peninsula is only 285 kilograms per hectare (about 251 lb. per acre). According to Mr. Richard, President of the Malay Peninsula Agricultural Association, the yield diminishes in the Federated Malay States after ten years of tapping, plantations of twenty years' standing having fallen from 800 lb. an acre in 1910–11 to 150 lb. in 1919–20, plantations having 150–200 trees to the acre after 10 or 11 years being reduced to 100–150 trees after 13 or 14 years, owing to brown-bast, bark-exhaus-

tion and death. The war, and the economic situation that has followed it, have so falsified all predictions as to make any calculations of future consumption very rash; but it is certain that the present fall in the price of rubber will be fatal to many plantations, so that those that survive the crisis and have by moderate tapping (such as monthly alternation) maintained the bark of their trees in good condition will find themselves in a better position for production when the price once more becomes remunerative. The controlling factor will be intensive scientific cultivation. After the crisis there will probably remain less than a million hectares in a productive condition, while rubber will probably have found new industrial outlets, so that the price is likely to rise, if not to pre-war rates, to one sufficiently profitable. While urging the maintenance and even the extension of the plantations of *Hevea* in Cochin China, M. Chevalier advises planters not to plant *Hevea* exclusively, but to grow coconut, coffee, tea, oil-palm, or sugar-cane as well, by way of insurance against any failure of the market for rubber.

NOTES

Imperial Institute Map of the Chief Sources of Metals in the British Empire, with Diagrams of Production.—A new and enlarged edition of this map, prepared at the Imperial Institute under the direction of the Mineral Resources Committee, is now published. The principal deposits of eighteen of the chief metals in the British Empire are shown on a general map of the world, and on a series of nine inset maps, drawn to a uniform larger scale, the deposits being indicated by prominent lettering, and by special symbols of distinctive colouring.

The diagrams show, both by figures and graphically, the output of the eighteen principal metals of all British countries and of the world.

The map is not only of value for educational purposes, but should prove of great service to those interested in the commercial aspects of metal production. It is obtainable from the Imperial Institute, either unmounted at 5*s.* 10*d.*

(post free) or mounted on rollers and varnished for wall use at 12s. 6d. (carriage extra).

Imperial Institute Monographs on Mineral Resources.—Two new volumes in this series of monographs have recently been published on *Silver Ores* and *Oil Shales*, respectively, both by H. B. Cronshaw, B.A., Ph.D., A.R.S.M. In each case the book is divided into three chapters. The first gives general information relating especially to the properties, uses and treatment of the materials under discussion, the second with deposits in the British Empire, and the third with foreign sources of supply. A map of the world, showing the location of the deposits described, is given in each volume, which concludes with a list of references to the literature of the subject.

Silver Ores has 152 pages, and is published at 6s. net. It gives statistics of production, describes the properties and uses of silver, and includes a list of silver ores proper, with brief references to the important base metal silver-bearing ores, and their metallurgical treatment. The important silver-producing regions of the British Empire, viz. those in British Columbia and Ontario, and at Broken Hill, New South Wales, are described in some detail. As regards foreign sources of supply, the principal silver-bearing deposits of Czecho-Slovakia, France, Germany, Hungary, Norway, Spain, Asia Minor, China and Japan, are briefly described, whilst the more important ores of Mexico, United States, Chile and Peru are dealt with at greater length.

Oil Shales contains 80 pages, and is published at 5s. net. A general account is given of oil shales and torbanites, of the mining and distillation of oil shale, and of the composition and properties of shale-oil. The oil shales of Scotland, Dorsetshire and Norfolk, of the Ermelo and Wakkerstroom districts of the Transvaal, and the Utrecht division of Natal, of Albert County, New Brunswick, and Pictou County, Nova Scotia, are described, as well as the torbanite deposits of the Blue Mountains region of New South Wales, and of the Mersey, Tasmania. A brief account is given of the oil shale deposits of Bulgaria, Esthonia, Germany, Italy, Yugo-Slavia, Arabia, China, Morocco, Chile and Uruguay, and fuller descriptions are provided of those of France, the United States and Brazil.

Manila Hemp: Cause of Damage in Recent Consignments.—The report of the Imperial Institute on the investigation of the cause of damage in Manila hemp (see this BULLETIN, 1921, **19**, 127) has been printed and issued to the

trade by Messrs. Wigglesworth & Co., Ltd., the well-known firm of fibre merchants, who suggested the investigation conducted at the Imperial Institute and supplied the samples of defective fibre for the purpose.

It has been reported recently that consignments of Manila hemp are still arriving from the Philippines in a damaged condition and that the local Bureau of Agriculture is conducting a special enquiry on the whole question.

Palm Oil as Motor Fuel.—One of the chief difficulties encountered in the development of the natural resources of West Africa is the lack of means of transport from the hinterland to the ports on the coast. As the use of animals is impracticable in many districts on account of the presence of the tsetse fly, and motor vehicles are too expensive to run, owing to the high cost of petrol and alternative motor fuels, the produce of the countries of West Africa has to be carried to the rivers and railways by the natives in loads of from 55 to 66 lb., in many cases for distances of thirty to sixty miles.

It is considered that if a cheap motor fuel could be obtained in West Africa, the development of the country and the extension of agriculture would be greatly benefited, as light motor tractors could be employed for transport, and motor power would be available for driving mills, cotton gins, oil-presses, and for generating electricity. Owing to the high charges for freightage, petroleum and its products are out of the question as motor fuels.

With a view to solving this problem, the suitability of vegetable oils as motor fuels has been investigated, as many of these oils, *e.g.* palm oil and ground-nut oil, are available in large quantities in West Africa.

Experiments made on behalf of the French Government in 1900 showed that ground-nut oil could be successfully used to drive Diesel engines, but the results do not appear to have been followed up. Prizes were offered by the Belgian Ministry of Colonies in 1920 for the best motor tractor employing palm oil or other vegetable oil as the motor fuel, but the competition was not held as there was only one entrant. Other bodies have also been engaged on the solution of this problem.

It is considered that an engine with the following specifications would be found suitable for use with palm oil: Complete combustion must be assured by the complete vaporisation of the fuel, which should be introduced in a quantity proportional to the load; the gaseous mixture should be constant, and capable of being regulated

by the injection of water, varying according to the load and the amount of oil fed in ; the exhaust gases must be completely removed from the cylinder.

Trials conducted by a Belgian firm have shown that a two-cycle engine of the semi-Diesel type, known as the "Drott" and made by a Swedish firm, answers the above requirements, and can be successfully used with palm oil. The "Drott" engine used in the trials was of the stationary type, and was adapted, but not specially designed, for use with palm oil. It was equipped with a storage tank for the oil, so fitted that the cooling water from the cylinder and the hot exhaust gases melted the contents. The tank was divided into three compartments by wire screenings, through which the melted oil filtered before entering the feed pipe. The engine was started from the cold with crude petroleum, and as soon as it was warmed sufficiently the petroleum supply was cut off, and the palm oil introduced through the automatic feed. Water was also injected automatically. This engine is light, strong and simple to operate, and is not fitted with any valves that are liable to get out of order. It was found that the palm oil neither clogged the engine nor left any perceptible amount of solid carbonaceous residue, and that even when using an oil containing a considerable quantity of free fatty acids no corrosion of the engine took place. It is stated that, at the temperatures prevailing in the Congo, palm oil is liquid, and that therefore no preliminary starting with petroleum will be necessary. Trials were conducted with an 8–10 h.p. engine, doing 500 revolutions per minute, and on substituting palm oil for petroleum no decrease in the number of revolutions or in power was noticeable. Both lower and higher power engines were also found to be satisfactory. The consumption of fuel was found to be 0·68–1·21 lb. per horse-power-hour for powers between 3·5 and 120 h.p. The fuel consumption was therefore about 20 per cent. more than with petroleum, but this is accounted for by the lower calorific value of palm oil, which is from 20 to 25 per cent. less than that of the mineral oil. In spite of the higher consumption in the case of palm oil, the total cost is much less than if petroleum were used, the former costing 250 francs per metric ton, and the latter 2,000 francs per metric ton.

Steamers and tugs, fitted with engines employing palm oil as fuel, have been run on the rivers of the Congo by several companies, who have found such engines to be quite satisfactory.

In the light of the results of these experiments, it is

quite possible that the use of engines driven by palm oil will be greatly extended in the future, especially as supplies of the oil can be readily obtained at almost any village in West Africa at a low price.

Agriculture in the Philippine Islands.—An interesting account of the present position of agriculture in the Philippine Islands is given in the *Twentieth Annual Report of the Bureau of Agriculture, Manila, for the fiscal year ended December* 31, 1920. The year under review was notable for the fact that greater progress was made and the farmers were more prosperous than in any previous year in the history of Philippine agriculture.

During the period 1910–1920 there was an increase of 45 per cent. in the area planted with the six principal crops, viz. rice, maize, Manila hemp, sugar, coconuts, and tobacco. For the five years 1915–1919 the average yields of these crops per hectare were, as a whole, 21 per cent. greater than those of the preceding five years, and the yield per hectare in 1920 was 4 per cent. above the average of the period 1915–1919. The value of these six crops has steadily increased from 159,000,000 pesos in 1915 to 687,000,000 pesos in 1920. Much of this increase in value is attributable to the high prices brought about by the war, but a large part is due to the increase in acreage and yield. The successful results of 1920 were obtained in spite of serious damage caused by typhoons and floods, and indicate that the improved methods of farming now practised lead to the production of better yields.

Rice.—The production of cleaned rice during 1920 amounted to 1,019,400 metric tons, and was nearly sufficient to supply the demand for local consumption, only 11,000 metric tons being imported. This is a remarkable improvement, as for three-quarters of a century the production of this cereal fell short of the requirements, and of late years this shortage increased. The yield in 1920 was 8 per cent. greater than in 1919, and was 33 per cent. above the average for the five-year period, 1915–1919.

Maize.—This crop was planted on 537,125 hectares, and produced about 553,000,000 litres of grain, which was the highest yield obtained during the last ten years.

Manila Hemp.—The area devoted to Manila hemp was 559,356 hectares, as compared with 515,563 hectares in 1919, and the production increased from 148,341 metric tons in 1919 to 165,081 metric tons in 1920.

Sugar.—In 1920 the area planted with sugar-cane was 1 per cent. less than in the previous year, but the yield of

sugar was 3 per cent. greater, and was the highest on record, the total production being 423,580 metric tons.

Coconuts.—The coconut crop also created a record in 1920, both with regard to the number of trees and the production of copra, which amounted to 361,605 metric tons, and consisted of 382 tons of steamed copra, 197,693 tons of smoked copra, and 163,530 tons of the sun-dried product.

Tobacco.—This crop also reached its maximum production for the past ten years, the yield in 1920 amounting to 64,894 metric tons of leaf, as compared with 56,498 metric tons in 1919. The areas planted in these two years were 101,123 hectares and 73,859 hectares respectively.

It is anticipated that during 1921 there will be a further increase in the production of all these principal crops, with the exception of Manila hemp. In this case, declining prices have discouraged growers, and it is anticipated that there may possibly be a decrease of 20 per cent. in the output of this fibre.

Among other crops, reference is made to maguey, the fibre obtained from the leaves of *Agave Cantala*, which was grown on an area of 30,567 hectares in 1920, as against 28,465 hectares in 1919, the production for the two years being 18,178 metric tons and 12,318 metric tons respectively.

Information is also given regarding the cultivation of vegetables and root crops, the total area devoted to these products being 141,211 hectares.

With regard to live stock, steady progress has been made during the last ten years, the records showing that carabaos have increased 96 per cent., cattle, 178 per cent.; horses, 79 per cent.; hogs, 90 per cent.; goats, 73 per cent.; and sheep 89 per cent. The actual numbers of these animals now present in the islands are as follows: carabaos, 1,388,244; cattle, 678,525; horses, 255,380; hogs, 3,129,676; goats, 731,849; sheep, 168,181.

The *Report* gives an account of the Bureau of Agriculture, its organisation and administration, and the work of its various departments, and contains a large number of excellent illustrations.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the BULLETIN *a summary is given of the contents of the more important papers and reports received during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India and the Tropics generally. It must be understood that the Imperial Institute accepts no responsibility for the opinions expressed in the papers and reports summarised.*

AGRICULTURE

FOODSTUFFS

Pruning Cocoa Trees as a Means of controlling certain Fungus Pests.—In the *Trade Supplement to the Nigeria Gaz.* (1921, **5**, 147) an account is given of the effect of pruning as a combative method against disease. It is pointed out that the average yield of cocoa per tree in bearing in Nigeria is about 1 lb. per year, whereas the same variety of cocoa grown under systematic supervision on estates under European management in the Cameroons yields on the average from 6 to 10 lb. per tree. Such a substantial difference is attributed chiefly to the adoption in the Cameroons of suitable measures for plant sanitation and disease control, whilst the Nigerian plantations are badly pruned, are ravaged by stem and pod diseases, and, in general, show lack of care in cultivation.

The diseases dealt with in the article include canker of the stem and pods, die-back, brown-root disease, and white-root disease.

It is pointed out that pruning, as an indirect method of combating disease, should be practised regularly in the pruning of healthy branches to produce a well-shaped tree. In unchecked growth, tertiary branches are often seen with a dense growth of leaves touching the ground, thus excluding light and air from the main branches, and providing ideal conditions for the growth of fungi. Pruning in this case is difficult, and, until the native farmer knows more about it, is better left to an agricultural instructor.

Rice Growing in California.—*Farmers' Bull., No.* 1141, 1920, *U.S. Dept. Agric.* (a revised edition of *Bulletin No.* 688, issued in 1914), gives a full account of the varieties of rice, the methods of cultivation and harvesting, and a general history of the rice industry in California. Varietal experiments commenced in California in 1909,

the first commercial crop of rice was produced in 1912, and, in 1919, 142,000 acres were devoted to the crop. The short-grained rices have been found more suited to the conditions in California than the medium and long-grained varieties. The latter did not develop normally, matured later, and produced comparatively low yields of grain of poor milling quality.

Cottonseed Meal for Horses.—*Bull. No.* 929, 1920, *U.S. Dept. Agric.*, contains a record of experiments to determine the value of this meal, which is very rich in protein, as a partial substitute for grain in a ration, and the amount which can with safety be fed to working horses. For the trials, sixteen horses were employed on a wide variety of work, and it was found that in most cases dislike was shown for the meal; but this was overcome by introducing it into the ration in small amounts at first, and increasing the quantity up to one pound a day per 1,000 lb. live-weight. This limit should not be exceeded, for in larger quantities digestive disorders may occur, and even death may ensue. The meal, which did not prejudicially affect mares, should be given in a thorough admixture with ground grain.

Black Spot of Citrus Fruits.—The *Philippine Journ. of Science* (1920, **17**, 635) contains an account of isolation and reinoculation experiments with the fungus, *Phoma citricarpa*, McAlpine, which causes black spotting of citrus fruits; the distribution of this disease is also dealt with. The spots are found only on the fruits, the leaves and twigs not being affected. So far the only kinds of citrus fruits which have been found to suffer are the sweet orange (*Citrus sinensis*) and the mandarin orange (*C. nobilis*). Pumelos (*C. maxima*) and calamondins (*C. mitis*), although grown in countries where the disease is common, have not hitherto been found to be affected. Although the disease is not serious, and could probably be prevented by spraying, it is desirable, in order to avoid the expense of spraying operations, to exclude it entirely by quarantine regulations from citrus-growing countries, such as Japan, California and Florida, in which it has not yet appeared. The occurrence of the disease on the China coast as far north as Foochow has been recorded, and McAlpine has reported it from New South Wales.

Oils and Oil Seeds

Castor Seeds.—A bacterial wilt of the castor plant is described in the *Journal of Agricultural Research* (1921,

21, 255). This disease has occurred in Florida during the last few years and caused a loss up to as much as 10 per cent. It has been noted that castor plants growing in the eastern portion of Florida are apparently not liable to the wilt, and it is thought that the abundance of lime in the soil of this district may be the cause of the immunity. Plants grown on newer lands are more liable to attack than those grown on land that has been longer under cultivation. The presence of the disease is indicated by the wilting of the green leaves and growing points, without previous yellowing or other discoloration. The wilt may occur when the plants are small, in which case it is likely to prove fatal, and is also found in plants of all sizes up to several feet high. In the case of the smaller plants, a single leaf may wilt, and the vascular system near the base of the plant on that side may show internal browning, or the whole plant may droop. The first manifestation often appears after a period of wet weather of several days' duration, but the wilt is more in evidence in hot dry weather. Although some plants may recover, the attack results, in the more severe cases at least, in the death of the plant. After wilting, the leaves dry and turn black, subsequently dropping from the plant, and leaving the bare black stalk and branches. Slight infection may produce dwarfing of the plant. As a result of cultures made from infected plants, it has been shown that the wilt is due to *Bacterium solanacearum*. This has been confirmed by inoculation experiments on tomato plants. When healthy castor plants were inoculated with this bacterium they wilted and showed the signs characteristic of the disease.

Experiments have been conducted at Sabour, Bihar, with the view of selecting and cultivating the variety of castor seed which gives the highest yield of oil (*Agric. Journ. India*, 1921, **16**, 146). A number of types were collected from the various districts of Bihar and their oil content determined. The amount of oil in the whole seed varied from 21·8 per cent. to 58·8 per cent. Fourteen varieties with a low percentage of oil (average 32·9 per cent.) and thirteen with a high percentage of oil (average 52·8 per cent.) were planted. The resulting types were found to be very impure, and the average quantity of oil in the produce from the "high" seed was estimated at 49·3 per cent., and in that from the "low" seed at 50·6 per cent. From this result it is assumed that the great differences in the oil content of the original seeds were due to the different conditions under which the plants were grown. A second series of experiments was under-

taken with seed obtained in the first experiments. In the case of "high" seed with an average oil content of 54·2 per cent., the new crop contained only 49·6 per cent., while from "low" seed with an oil content of 42·5 per cent., the descendants yielded 48·6 per cent. There appear, therefore, to be strong indications that, in the majority of cases, the plants do not transmit a high or low oil content for even one generation, but that both "high" and "low" seeds, when grown under identical conditions, give plants which in nearly every case bear seed containing about 49 per cent. of oil.

Miscellaneous.—*Bulletin No.* 20 of the *Department of Agriculture and Natural Resources, Bureau of Forestry, Philippine Islands,* is devoted to a study of the resins, gums, oil seeds and essential oils of the Philippine Islands. This *Bulletin* gives the scientific and local names of the Philippine products, which are the basis of commercial industries or which offer promising possibilities. The general uses and importance of the products are discussed, and a description of each specie and a short account of its distribution and abundance are included. The *Bulletin* is well illustrated with photographs and figures.

A short survey of the oils and waxes produced in Latin America is published in *Chem. and Met. Eng.* (1921, **24**, 1101). The chief oil seed of economic importance is linseed, which is cultivated on about 3,000,000 acres in Argentina. Most of the seed is exported, very little being crushed in the country of production. Coconuts, cohune nuts, castor seed and cotton seed come next; but they have not yet become nearly so important as linseed. Other seeds which grow wild or have been cultivated to some extent in this part of America are: sesame, ground nuts, olives, babassu nuts, ucuhuba nuts, Brazil nuts, mustard seed, Para rubber seed, and Niger seed. Although these seeds have not been exploited to any great extent, some of them have been exported in small quantities. Carnauba and candelilla waxes are the two chief waxes of commercial importance from this region. Over 13,000,000 pounds of the former wax, which is plentiful in the State of Ceara, were exported from Brazil in 1919. The leaves of the palm tree which furnishes this wax are gathered from September to March, 2,000 to 4,000 leaves being required to produce 16 kilos. of wax.

Rubber

Hevea

Ring-rot Disease.—A short account, with illustrations, is given in *Archief voor de Rubber-cultuur* (1920, **4**, 495) of a bark-rot disease occurring commonly in Sumatra and found also in Malaya. The diseased bark becomes sepia-coloured in the initial stage, and subsequently dries up and scales off in concentric patches. The cause of the disease is not yet known, but is thought to be due to a fungus; it can be eliminated by scraping away the diseased bark, and in some cases disappears without treatment.

Selection of a High-yielding Strain of Hevea Resistant to Brown Bast Disease.—*Med. van het Inst. voor Plantenziekten*, No. 42 (1920), gives an account of experiments conducted at Buitenzorg with the object of ensuring that trees raised from the seed of old trees shall be resistant to brown bast. Trees yielding the most latex, and, therefore, the most desirable to propagate, were subjected to severe over-tapping by cutting five or six times a day. Under this treatment trees susceptible to brown bast soon developed the disease, while those remaining healthy were considered to be the best resistant stock for propagating. A section of the Economic Garden has been planted with the progeny of a high-yielding resistant tree, and will be kept under observation.

Tapping Systems.—A lecture on the respective advantages of daily tapping and alternate day tapping given by Mr. Pinching, Mycologist to the Rubber Growers' Association, before that Association and the Society of Planters at Ipoh, Malaya, is reported in *The Malayan Tin and Rubber Journal* (1921, **10**, 189). The case for each system was reviewed by the lecturer, who drew attention to a common error that arises in making a comparison. In adopting the alternate day tapping in place of the daily system, planters are apt to compare the yield with the previous yields obtained under the daily tapping system, whereas the trees have become older and the yields, generally speaking, would have increased had daily tapping been continued. The drop in the yield by transferring to alternate day tapping is, therefore, greater than is at first apparent. The most authentic figures on record show that alternate day tapping yields 60 per cent. of that obtained by daily tapping, for equal length of cut. Alternate day tapping has an advantage over the daily system in requiring only

half the number of tappers, and, as tapping represents 75 per cent. of the estate labour, a great reduction in working costs is achieved under the former system. Further advantages are that the consumption of bark decreases, and the trees are less prone to be affected by black thread and brown bast diseases. Mr. Pinching calculated the profits under the respective systems, and showed that, whereas by alternate day tapping the cost of production is less and the output less, the factors determining the financial success are the current price of rubber, and the actual percentage of the daily tapping yield obtained by the alternate day tapping. When the yield is as high as 90 per cent. of that from daily tapping, and with normal prices (say 75 cents per lb.) prevailing, then the profits from alternate day tapping would equal those from daily tapping. With a smaller percentage yield, say 60 per cent., alternate day tapping will not give the same profits as daily tapping, though as the selling price decreases the advantage of the profits from daily tapping over those from alternate day tapping gradually diminishes. Finally, a point is reached where the profits from both systems of tapping are equal, that is nil, and occurs when the selling price is about 35 cents and alternate day tapping gives 74 per cent. of the yield obtained by daily tapping. It follows that when the price of rubber is 40 cents a lb., alternate day tapping, giving a 60 per cent. yield will not pay, and only commences to pay when the yield is 75 per cent. of that obtained by daily tapping.

Uniformity in Rate of Cure of Crêpe from Slab Rubber.—A large number of samples of ordinary crêpe rubber and crêpe made from matured slab, all prepared from the same latex, were examined by the Consulting Chemist of the Rubber Growers' Association in order to determine the variation in the rate of cure, and the results are recorded in the Association's *Bulletin* (1921, **3**, 47). It is shown that crêpe from slab rubber gives larger variations in the rate of cure than ordinary crêpe, and this disadvantage might conceivably negative the advantage crêpe from slab possesses over ordinary crêpe in virtue of its quicker rate of cure. Certain rubber manufacturing companies have of recent years shown a preference for slab rubber, and have produced this form on the plantations owned by them. It has been argued that plantation companies generally should abandon the present production of crêpe sheet in favour of pressed slabs. The position of producers who have to sell on an open market which has become accustomed to clean, dry rubber that

can be judged by mere inspection, is, however, different from that of the companies referred to above, and the market generally has so far only accepted slab at a price below that of standard crêpe and sheet. It is possible that for some classes of manufacture, the merits of slab, in spite of the greater variability in rate of cure, may be recognised, and an increased demand for that type of rubber result.

FIBRES

Hibiscus cannabinus.—The fibre of *Hibiscus cannabinus* is cultivated in India, chiefly in Madras, and is known as "Ambari hemp," or "Deccan hemp." A large quantity of the fibre is produced in Madras and exported to the United Kingdom, where it is sold under the name of "Bimlipatam jute," and realises prices approximately equal to those of medium grades of Calcutta jute.

The plant is widely distributed in the tropics, and grows in many parts of the British Empire. Samples of the fibre from India, Egypt, Gold Coast, Rhodesia and the Union of South Africa have been examined at the Imperial Institute, and reported on in this BULLETIN (1912, **10**, 53; 1915, **13**, 22; 1917, **15**, 10; 1919, **17**, 469; 1920, **18**, 430).

Hibiscus cannabinus is abundant in French West Africa, where it is known by the natives as "Dà," and a somewhat lengthy memoir on "Le Dà de l'Afrique Occidentale Française au Point de Vue Textile," by Dr. F. Heim, in collaboration with O. Roehrich, Dr. Rullier and J. Rolland, has recently been published in the *Bulletin de l'Agence Générale des Colonies* (1921, **14**, Nos. 160–161, p. 341; Nos. 162–163, p. 473).

In French West Africa the plant covers large areas in the valleys of the Niger and Bani, in the circles of Bamaku, Ségou, Mopti, Djenné, Koutiala and San, where it exists in several forms which are regarded as identical with the Indian varieties. The natives of these regions recognise three different forms of the plant, viz.: (1) "Dà oulou," which grows wild on the inundation area of the Niger, in the basin of the Débo; (2) "Dà des Somonos," which is cultivated on the borders of the Niger and Bani in all the plains periodically inundated when the waters are at their greatest height; (3) "Dà fa," which grows on dry areas, and is cultivated as an intercalary crop among maize or millet on open and well-drained land. These different forms are described, and it is pointed out that those grown on the inundated lands are not pure, but consist of mixtures

of varieties produced by cross-fertilisation, whilst those grown on dry lands are generally more homogeneous.

The plants are propagated by means of seed which is sown in June, and the crop is harvested during the first fortnight of November, when the capsules ripen. The stems are either uprooted or cut off at the base. They are allowed to dry in the sun for four or five days and, after the leaves have been stripped off, they are made up into bundles, and retted either in running or stagnant water. In order to keep the bundles submerged, they are either loaded with sods or sand is heaped on them. Retting has generally proceeded sufficiently at the end of six to ten days, according to the temperature of the water and other conditions. The bark, after being stripped from the stems, is scraped with a knife, and the resulting fibre is washed and allowed to dry. The fibre obtained in this way is generally defective, the upper end of the stem being over-retted, whilst the lower part is not retted sufficiently, and black patches of bark remain attached to the fibre; moreover, the fibre is generally of a dark grey colour. In some districts, in which water is scarce, strips of bark removed from the freshly cut stems are hung on hurdles beneath the shade of banana leaves, watered moderately at regular intervals, and finally washed and dried.

The yield of fibre amounts to from 700 to 1,500 kilos. per hectare (or about 600–1,300 lb. per acre), representing 20–25 per cent. of the weight of the dry stems, or 3–4 per cent. of that of the fresh stems.

A careful comparative study has been made of the microscopical characters and tensile strength of fibre obtained (1) by retting in stagnant water, and (2) by retting in running water. After nine days' retting in stagnant water, the fibre obtained is coarse and harsh, of a dirty yellow colour and dull appearance. On the other hand, after forty-two days' retting under the same conditions, a fine filasse of well dissociated strands is obtained, which is supple and soft to the touch, of a very pale yellow colour and a silky, lustrous appearance. The products resulting between the ninth and twenty-fourth days of retting resemble the coarse fibre described above, whilst those from the thirty-fourth to thirty-eighth day are similar to the silky fibre. The fibres obtained between the twentieth and thirty-fourth days are of an intermediate character. Similar transformations were observed in a series of retting trials in running water.

The microscopical examination and tensile tests have shown that, in the case of stems retted in stagnant water, the attack of the cellulose wall of the fibre is much advanced

before the separation of the fibrous bundles from the parenchymatous tissue has been effected, and this affords an explanation of the fact that from the twentieth day of retting the tensile strength diminishes, whereas the optimum separation of the strands is not obtained until the thirty-fourth day. In running water, however, the dissolution of the pectic matter is more rapid; on the twenty-third day, when the retting is completed, the attack of the cellulose of the walls of the fibre is still insignificant. It follows, therefore, that it is always best, when possible, to ret in running water; in twenty-three days a strong and lustrous fibre is obtained. If, however, it is necessary to use stagnant water and a silky fibre is required, retting must be continued for at least thirty-four days at the cost of the strength of the fibre; or, if a strong fibre is desired, the period of retting must not exceed twenty days, and, in this case, only a coarse and coloured product is obtainable.

A study has also been made of the bacterial agents of fermentation in the retting of Hibiscus fibre, and the various organisms identified are recorded.

Reference is made to a method of preparing the fibre by stripping the bark from the stems and subsequently degumming it by means of chemicals. A decorticating machine, devised by F. Michotte, is described, which is capable of treating 1,000–1,500 kilograms of stems per hour; it requires 4 h.p. and the services of two workers. The machine is portable, and this renders it possible for the fresh stems to be decorticated on the spot. The stems are passed between rollers and then subjected to the action of a beater. The strips of bark thus obtained are then boiled with a chemical solution, and yield a nearly white, well-divided, silky and flexible fibre.

A detailed account is given of an investigation of the characters of the ultimate fibres and of the chemical composition and physical constants of the filasse. The ultimate fibre was found to have a length of 2–6 mm., with an average of 2·5 mm., and a diameter of 17 to 25 μ, with an average of 20 μ.

In comparison with jute, the fibre of *Hibiscus cannabinus* is stated to be shorter and a little less flexible, whilst, on the other hand, it is stronger, more lustrous, more resistant to the action of water and of the same degree of fineness. It can be used for all the purposes to which jute is applied.

The paper is well illustrated, and concludes with a bibliography of the subject.

New Zealand Hemp.—A valuable and well illustrated article on *Phormium tenax* and the fibre industry of New Zealand has been contributed by Edmond H. Atkinson, of the Biological Laboratory, Wellington, to the *New Zealand Journ. Agric.* (1921, **22**, No. 2, 81; No. 4, 203; No. 5, 283; and No. 6, 347).

The article begins with an historical sketch, dealing with the spread of knowledge concerning the fibre from the time of its discovery by Captain Cook during his voyage to the South Seas in 1768–1771. The development of the fibre industry is then traced from the first exports of the fibre in 1830 up to the present day, special consideration being given to the introduction of machinery and the establishment of the grading system.

The second chapter of the article deals with Phormium from the botanical standpoint. The distribution of the genus and of the two species *P. tenax* and *P. Colensoi*, is discussed, both species are fully described, and a full account is given of the microscopical structure of the leaf, the position and nature of the elements which form the fibre of commerce being clearly demonstrated.

The third chapter treats of the method of conserving and cultivating the crops. Reference is made to the advantages gained by draining the swamps, this practice resulting not only in increasing the luxuriance of the Phormium itself, but also in the replacement by it of such plants as *Typha angustifolia* and the establishment of an almost pure growth of Phormium. It is estimated that drainage of the swamps has converted at least 50,000 acres of unprofitable land into good phormium-producing areas. The best methods of cutting the leaves are described, and it is stated that phormium swamps, as treated at the present day, will yield every three or four years about 25 tons of green leaf per acre in good areas, though up to 40 tons per acre has been harvested in exceptional cases. The methods of propagating the plant, both by division of the rootstock and from seed, are briefly considered.

The last chapter deals with the various processes adopted for the extraction and preparation of the fibre for the market. After describing the methods of obtaining the fibre which were practised by the Maoris, the author gives a short account of the evolution of the present methods, and gives a detailed description of the machinery and processes in use at the present time, including the operations of stripping, washing, bleaching, scutching and baling. It is stated that, on the average, 8½ tons of green leaf will produce 1 ton of fibre and 4 cwts. of tow. The

present method of extracting phormium fibre is regarded as capable of considerable improvement, especially in the process of stripping. The extraction of the fibre from the green leaf by the beating operation reduces the strength of the material, and produces a large amount of waste.

In the *New Zealand Journal of Science and Technology* (1921, **4**, 34) an account is given of a discussion on the New Zealand hemp industry, which took place at the New Zealand Science Congress, held at Palmerston North in January, 1921. Special reference was made to the ravages of the yellow-leaf disease (see this BULLETIN, 1921, **19**, 79), which is said to have caused the abandonment of 5,000 acres of phormium swamp in 1920. It was considered that the only means of controlling this disease is by the establishment and use of disease-resistant strains. The Congress appointed a committee of flax millers and other members to consider the question of the establishment of a biological station for the thorough investigation of the yellow-leaf disease in all its aspects. This Committee reported (1) that the first essential of the problem is to ascertain whether races of Phormium exist which are resistant or immune to the disease; (2) that for the conduct of this research a small experiment station should be erected, which should be under the direction of a committee of the Flax Millers' Association, and placed in charge of a skilled plant propagator, with one or more assistants; (3) that a levy of 2*s.* per ton on New Zealand hemp should be collected through the Grading Department, and devoted to payment of salaries and the cost of building, equipment and upkeep of the experiment station.

Cotton

West Indies.—An account of the progress of the cotton industry in St. Kitts-Nevis is given in the *Rep. Agric. Dept., St. Kitts-Nevis*, 1919–20. The acreage devoted to cotton during the season under review was somewhat less than in the preceding season, owing to the anticipated high price for sugar and the shortage of labour in Nevis. The total area was approximately as follows: St. Kitts, 1,500 acres; Nevis, 2,000 acres; Anguilla, 800 acres; total, 4,300 acres. The weather conditions in St. Kitts were, on the whole, fairly good, and the average yield of lint per acre was about 150 lb. Most of the cotton was sold locally at prices ranging from 4*s.* 9*d.* to 6*s.* 6*d.* per lb. for clean lint, and from 2*s.* 3*d.* to 3*s.* 3*d.* for stained. A few planters shipped their produce direct to England, and obtained 8*s.* 4*d.* per lb. for clean lint. In Nevis the con-

ditions were unfavourable, and caused considerable loss, particularly to the small growers. In Anguilla the cotton suffered at first from lack of rain, but the late rains were satisfactory, and enabled a fair return to be obtained. The total production in the Presidency for the year ending September 30, 1919, amounted to 566,774 lb. of lint, and the exports to 797,762 lb.

Manurial and selection experiments were continued at the Botanic and Experiment Stations on similar lines to those adopted in previous years. The manurial experiments resulted in the production, on the average, of 1,980 lb. of seed-cotton, or 500 lb. of lint per acre. The return from plots dressed with pen-manure was very large, amounting to 2,600 lb. of seed-cotton, or about 700 lb. of lint per acre.

In March 1920 a Government Cotton Seed Farm was established at La Guérite. Pedigree seed of the strain No. 342 grown at the Experiment Station was planted on 42 acres, and gave an average yield of lint of about 400 lb. per acre. The seed obtained from the first picking amounted to 36,000 lb., and was sold to growers at 2d. per lb. The whole of the seed was eagerly purchased, the supply being scarcely sufficient to meet the demand. A further area of 23 acres has been added to the farm for the season 1920–21.

United States.—The annual production of Sea Island cotton in the United States declined from 92,619 bales in 1917 to 6,916 bales in 1919, and it is feared that the growth of this variety will cease entirely within the next few years. This unfortunate situation is due to the ravages of the boll weevil, which has now invaded the Sea Island districts.

In order to provide for this contingency, the Bureau of Plant Industry of the U.S. Dept. Agric. has developed during 1912 and subsequent years a new variety of cotton to replace the Sea Island crop. This new cotton, which is known as "Meade," was produced from the "Blackseed," or "Black Rattler" variety. It matures two or three weeks earlier than Sea Island cotton, gives a greater production of both lint and seed, bears larger bolls, and is therefore more easily picked.

Meade cotton is a long-stapled Upland form, producing, under favourable conditions, a fibre varying from $1\frac{7}{16}$ to $1\frac{3}{4}$ ins. in length, with an average of $1\frac{5}{8}$ ins., and of a fineness resembling that of Sea Island. In general, Meade cotton is so similar to Sea Island as to be almost indistinguishable from it. The seeds are nearly smooth,

ınd the cotton can, therefore, be removed by an ordinary oller gin.

Spinning trials have been made with representative ıales of Meade and Sea Island cotton grown during the easons of 1916–17, 1918–19 and 1919–20 in order to .etermine their comparative spinning value, and an account f the results obtained is given in *Bull. No.* 946 (1921), *J.S. Dept. Agric.*, by W. R. Meadows, Cotton Techno- ɔgist, and W. G. Blair, Assistant in Cotton Testing. The esults show that, on the average for the three seasons' otton, the Meade cotton gave 3·5 per cent. more waste han the Sea Island in the various processes preparatory ɔ spinning. Comparing the breaking strength of the leade and Sea Island yarns for the three seasons, a ifference of 17·2 lb. was found in favour of the Sea Island ɔr 23's yarn, and 1·68 lb. for the 100's yarn. In the case f the cottons produced during the 1919–20 season, 'hen adverse weather conditions prevailed, the breaking :rength of Meade grown on sandy soil was equal to that f the Sea Island for the finer counts of yarn.

In the *Journ. Agric. Res.* (1921, **21**, 117) there is a aper by C. S. Scofield, Agriculturist in Charge, Western :rigation Agriculture, Bureau of Plant Industry, U.S. 'ept. Agric., on "Cotton Root-rot in the San Antonio .otations." Root-rot has been prevalent on the San .ntonio Experiment Farm since cotton experiments were :gun there in 1906, but no records were made of the :currence of the disease until 1912. In that year the ımber of plants affected by root-rot were counted in a ries of crop rotation experiments, and the proportion of ıch plants to the total number of plants in the plots was ımputed. Similar observations have been made in each cceeding year, and the results are now published of experi- ents carried on for eight years (1912–1919). It has been ggested that the best remedy for root-rot lies in the loption of a suitable rotation of crops, supplemented by ep ploughing and thorough tillage. A large number of periments have therefore been made on these lines, and servations have also been made of the influence of farm- rd manure and green manure crops. Careful considera- ın of the whole of the results of this work has led to the nclusion that the extent of root-rot injury was not ected by different crop sequences, by different tillage :thods, or by the application of farm-yard manure or : use of green manure crops, and that the disease can- t be controlled by any ordinary system of crop rotation tillage operations.

FORESTRY AND FOREST PRODUCTS

Timber Trade and Resources of Mexico.—A detailed report on the present condition of the import and export trade in timber in Mexico, with some notes on the resources of the country, appeared in the *United States Commerce Reports*, No. 51, March 3, 1921. The trade consists mainly in the import of softwood from the United States, and in the export of mahogany and "cedar" to that country, of dyewoods, more than half of which comes to the United Kingdom, and of fustic, more than half of which goes to France. The softwood imported is mostly long-leaf yellow pine (*Pinus palustris*), of which nearly 74,000,000 board-feet were received—chiefly in plank—in 1920, together with some short-leaf pine (*P. echinata*), cypress, and redwood (*Sequoia sempervirens*). The last-named timber, and some of the pine, comes from the Pacific Coast to Acapulco. The value of the softwoods imported from the United States totalled nearly 5,000,000 dollars in 1920; but the disturbed state of the country has checked railway extension and thus reduced the demand for sleepers. Mexico is believed to produce about half its home demand for softwoods; but the absence of transport facilities prevents the utilisation of much of its resources, and leads to the employment of hardwoods for inferior purposes. The demand for constructional softwood timber is lessened by the absence of frame-built houses, the doors and window-frames of the universal adobe-built structures being made from home-grown pine. Though the mines of the province of Chihuahua import Texas long-leaf pine for props, they use still more native timber. Oak and hickory are imported there for waggons, etc., and "gum" (*Liquidambar styraciflua*) is also among the chief species imported.

There are stated to be at least 200 species of native timbers in Mexico, mostly in the southern provinces. The mahogany (*Swietenia*) and "cedar" (probably *Cedrela odorata*) are employed locally for barge-building. They are largely exported from Frontera in Tabasco, as also are the dyewoods. The value of the mahogany exported to the United States is nearly 750,000 dollars; and that of cedar over 500,000. Though considerable quantities of oak have been exported from Vigia in Sonora to the United States as firewood, there is a scarcity of fuel in many parts of Mexico, which leads to the use of ebony and valuable dyewoods for this purpose at some of the mining centres.

In addition to the species mentioned, Mexico possesses several useful kinds of pine, red and white oak, rosewood

mesquite, balsa, granadillo, palo maria (probably *Calophyllum Calaba*), etc.; but most of these have neither been precisely identified, nor to any extent exploited commercially.

Wood Technology in India.—Though the Indian Forest Service has already done a good deal in the scientific testing of Indian woods and of proposed methods of seasoning, the establishment of a special departmental division for wood technology, both experimental and educational, in the United Provinces, is practically a new departure. In October 1918 this Division was established at Bareilly on the basis of the Bareilly Carpentry School, and the Report of its first complete working year has now been published at the Government Press of the United Provinces at Allahabad. Its objects are two-fold, viz. the training of workmen in all branches of wood-working and the investigation of methods of seasoning and utilising the less known woods of India, and of obtaining a market for them in a converted or manufactured state. A site covering more than 20 acres has been acquired, with the drawback that it is at present two miles from the railway, and a machine shop has been erected and fitted, which is stated to be the most up-to-date in India. Wood refuse is almost the sole fuel, and the machines are operated by a 120-h.p. steam-engine. Arrangements are being made for planing, moulding, handle and bobbin turning, wood-bending, veneer-cutting and the manufacture of ply-wood and wood-wool. The elementary course is planned for three years cabinet-making and joinery and toy-making; turnery and cooperage are to be taught when the staff of experts, which at present seems only to number four, has been increased. Experimental work has been directed to woods suitable for bobbins, hammer and other handles, barrel staves and brush-backs. For bobbins the most suitable species have been found to be haldu (*Adina cordifolia*), and kanju (*Holoptelea integrifolia*); for handles, dhaura (*Anogeissus latifolia*) and asaina (*Terminalia tomentosa*); and for brushes, ash (*Fraxinus floribunda*), holly (*Ilex dipyrena*) and haldu. Large numbers of barrel staves and heads for slack cooperage have been made from chir (*Pinus longifolia*); and this and the two other common softwoods of Northern India, the spruce (*Picea Morinda*) and the silver fir (*Abies Webbiana*) are being utilised for match-boarding, cornice-moulding, window-frames, etc. These woods are being tried in railway-carriage building and may, it is hoped, to some extent replace the large quantities of pine at present imported.

Woods for Aeroplanes.—The Forest Products Laboratory of the United States Forest Service has prepared eight monographs for the National Advisory Committee for Aeronautics. The first of these (*Report No. 65*), which is to appear in the *Fifth Annual Report of the Committee*, is on "The Kiln-drying of Woods for Airplanes," and is by H. D. Tisman. Though necessarily traversing much of the ground covered by his book on the same subject, published in 1917, the treatment is simpler, briefer, and strengthened by the experience of the last few years. Some of the main conclusions, set forth in an "Introduction," are of such extreme practical importance as to claim publicity in all wood-using countries; but the emphatic qualifications of his conclusions must not be overlooked. "A very gradual seasoning at air temperature, provided conditions are properly controlled, cannot be excelled in its effect upon quality. This is true for the reason that the moisture difference between the outer surface and the interior is thereby kept at a minimum, so that no appreciable stresses are brought about by unequal shrinkages." "Ordinary air seasoning, on account of its vicissitudes due to inability to control the process, is far from an ideal method of conditioning, even though the element of time did not enter into the question. This is particularly true for the more refractory and the more valuable woods, and for all woods which are required for very exacting purposes, such as airplanes." "The chief reason for kiln-drying in the past has been a saving of time." "It must be admitted that the results formerly obtained . . . tended to create a prejudice in favour of the time-honored methods of slow air seasoning. The application of artificial heat, in the absence of thorough scientific knowledge of the principles involved and the development of a correct technique, resulted in much injury to the wood in checking, loss of strength, and warping." "The exigencies of the war and the scarcity of air-dried material necessitated the kiln drying immediately, from the green condition, of practically all of the wood used in the United States for airplanes. This was a complete reversal of established practice and, from the standpoint of commonly accepted beliefs, was a dangerous innovation. England and France specified against 'kiln drying' airplane woods, but in certain instances permitted 'conditioning,' that is, allowing the lumber to remain in a slightly heated room, usually at 25° C. (77° F.) or 30°C. (86° F.)."

"To air dry Douglas fir wing beams requires ordinarily from twelve to eighteen months. They may be kiln-dried

in eighteen to twenty-four days. To air-dry hardwood propeller stock takes at least one, and preferably two years. The same material can be kiln-dried and brought to equally good condition in a month's time." "Exhaustive strength tests made recently by the Forest Products Laboratory have shown beyond question that properly kiln-dried wood is just as strong, tough, and stiff as the best air-dried material. Kiln-drying for special purposes, such as air-planes, should be looked upon as a highly technical art. Lumber can be much more easily injured in a dry kiln than if left to dry in a shed exposed to the air, and, unless the kiln drying is properly conducted, air drying is safer. But if the kiln is in charge of a technical expert, and the process is carried on in a scientific manner, kiln-drying is greatly to be preferred to ordinary air-drying."

The examination of portions of captured German aero-planes at the Imperial Institute showed not only that the enemy, like the Allies, had been driven to the use of kiln-drying, but also that in some cases at least the process had been so faultily conducted as seriously to damage the wood from a constructional point of view.

Though there is no direct reference to methods of seasoning, many cognate topics are dealt with in considerable experimental detail in the timber section (Chapter X, pp. 95–131) of the *Report on Materials of Construction used in Aircraft and Aircraft Engines*, by Professor C. F. Jenkin of Oxford, published by our own Aeronautical Research Committee (H.M. Stationery Office, 1920, price 21*s.* net). This chapter is mainly based on researches made by Major A. Robertson, who, though he expresses the opinion that wood will be ultimately replaced by steel for spars and struts, admits that, up to the end of the war, timber, owing to its remarkable combination of strength and lightness, held its position as the best material for these, for longerons and for many other parts of aeroplanes. Most of the testing experiments described by Major Robertson refer to silver spruce (*Picea sitchensis*), though it is admitted that some western hemlock (*Tsuga Mertensiana*) and larch (*Larix occidentalis*) came to this country under the name of silver spruce.

The Air Board specification recognised, as "approved substitutes" for silver spruce, first quality wood of Quebec *Picea alba* or *canadensis* and *P. nigra* or *mariana*, West Virginian or North Carolina *P. rubens*, White Sea *P. excelsa*, White Sea red deal (*Pinus sylvestris*), Canadian white pine (*P. Strobus*), Port Orford cedar (*Cupressus Lawsoniana*), New Zealand kauri (*Agathis australis*), or Oregon pine (*Pseudotsuga Douglassii*). The substitution

of smaller spars of the heavier woods imported as "pitch pine," viz. *Pinus palustris*, *echinata*, *Tæda* and *heterophylla*, is justified; but the figures given for Victoria blackwood (*Acacia melanoxylon*) do not appear to recommend that heavy timber. The report not only recognises—as might be supposed—the extreme heterogeneity of wood as a material for the engineer, but also rightly points out that the strength of timber increases considerably as the moisture content is reduced. This being so, the reprinting of long series of tests in which the moisture content is not stated appears to be a mere waste of paper.

MINERALS

General

Tanganyika Territory.—In a report on the trade and development of Tanganyika Territory by H.M. Trade Commissioner in East Africa, March 1921, it is stated that, whereas in pre-war days the only minerals exported were gold and mica, there seems good reason to believe that the following could be successfully exploited: coal, copper, lead, silver, mercury, graphite, asbestos and lignite. The factory producing salt at Gottdorp, sixty miles east of Kigoma, has been very remunerative, the product being disposed of locally and in the Belgian Congo. A geologist has been appointed to report on the whole question of the mineral resources. The great difficulties of transport and unhealthy climatic conditions militate severely against development in many localities, particularly the gold district of Muanza.

Canada.—The ore deposits of British Columbia are briefly described by Stuart J. Schofield in a paper published in the *Bull. Can. Inst. Min. and Met.*, August 1921, which gives a résumé of the work of the Geological Survey in this State for the past fifty years. The author states that in general the ore deposits of British Columbia are of primary origin, the most favourable rocks for the location of ore-shoots are stratified or bedded types, but that the igneous types are the more valuable commercially. The influence of rock structures is shown to have a profound effect on ore-deposition, and the author points out that practically all the deposits have resulted directly or indirectly from grano-diorite intrusions of upper Jurassic age.

Yugo-Slavia.—A report on the geology and mineral resources of the Serb-Croat-Slovene State by D. A. Wray, of the Geological Survey of Great Britain and of the Department of Scientific and Industrial Research, has

recently been published by the Department of Overseas Trade. It consists of 100 pages, and is divided into three parts. Part I, which is introductory, contains a brief résumé of the progress of the mining industry, mineral output, labour costs, etc., in Yugo-Slavia, together with means of communication, establishment of central power stations and reconstruction of the mineral industry. The geology of the state is briefly described in Part II. The mineral resources are described in detail in Part III, and include coal, iron-ore, manganese, chromium, antimony, gold, silver, mercury, copper, lead and zinc, aluminium, magnesium, sodium, etc.; this portion of the work concludes with oil, asphalt, paraffin shales, etc., and building stones and materials. There are appendixes of bibliography (1840–1919), a glossary of some Serbian mining terms, and the Serbian mining law of April 5, 1866, with amendments and amplifications of later date (18 pages). The work is illustrated with views, etc., from photographs, a large folding map on a scale of 1 : 1,500,000, and various sections of mineral deposits, sketch-maps, etc.

The report is most interesting and useful, as it supplies a good deal of information about a country of which little has hitherto been published.

A summary of the information relating to antimony, coal, copper, gold, iron, lead and zinc, manganese, oil shales and petroleum, is given under their respective headings in the following pages.

Antimony

Yugo-Slavia.—According to the Report by D. A. Wray, mentioned on page 400, the most important antimony deposits of Yugo-Slavia occur in the Kostainik-Krupanj district of Serbia, where limestones, shales, slates and sandstones are traversed by dykes and sheets of trachyte and andesite. At Stolitsa, tufts and threads of quartz and calcite are accompanied by stibnite; at Roviné, veins of quartz and calcite with stibnite occur in shales and slates; and at Kostainik the deposit is interbedded, consisting of a thin bed of a dark finely crystalline groundmass of quartz with tufts of acicular stibnite.

There are small smelting works at Zajatcha and Dobri Potok. In the former place, stibnite occurs in acicular masses in quartz, either (1) as stringers in altered trachyte, or (2) as stratified masses overlaid by thick bedded limestones, and underlaid by compact limestone. At Dobri Potok stibnite occurs in well-formed needles in large masses in the limestones, probably of Cretaceous age.

Asbestos

Canada.—An account appears in *Can. Mining Journal*, July 22, 1921, of the erection of a plant to manufacture asbestos into all classes of products at Asbestos, Quebec. Hitherto this Province, although producing 85 per cent. of the world's output of asbestos, has exported practically the whole of its raw material, being content to manufacture only comparatively few asbestos boards at Lachine. There would appear to be scope for the development of a large industry in these products. It is stated that a plant at East Broughton is now making brake linings (*Bull. Can. Inst. Min. and Met.*, August 1921).

Bauxite

Togoland.—An account of deposits of bauxite in Western Togoland is given in a report by Thomas Robertson on the geology of that area, published recently by the Government of the Gold Coast. Bauxite occurs on the Agu Mountains, but all the other laterite deposits are of the ordinary impure type. From Pole to Sodo, along the foot of the Togo scarp, patches of laterite appear in many of the stream banks; there is much laterite on the low ground near the Chra River, and, in addition to a few minor areas, a well lateritised area occurs north of the Asuokoko. The Adele Highlands, for instance, show extensive lateritised areas. At Bismarckburg, 40 ft. below the railway station there is a hard siliceous laterite of a brown colour, which covers the ground for about 600 ft. along the road towards Yega. Next to this comes 450 ft. covered with softer, semi-consolidated laterite, less siliceous than that above, and dark brown in colour. Then follow 900 ft. of red earth, over 8 ft. thick in places, merging downwards into weathered schist. The different zones are probably only different phases in the process of lateritisation. The distribution of the laterite is quite independent of the petrological nature of the underlying rocks.

Chromium

Rhodesia.—In the *Report of the Southern Rhodesia Geological Survey* for 1921 H. B. Maufe describes the result of a further investigation of the chromite deposits in the Umvukwe Hills. The ore is in seams, generally less than a foot thick in the central portion of the Great Dyke, and its occurrence has been compared with that of a series of coal seams lying one above the other in a basin.

The country-rock is usually enstatite, partly serpen-

tinised, but in some cases the floor of the seam is enstatite and the roof serpentine, which appears to be derived, either from a dunite or a saxonite. The synclinal structure of the dyke at this point is similar to that in other parts of the dyke described by P. A. Wagner and others. The method of deposition of chromite in the Great Dyke differs widely from that of the well-known Selukwe deposits, or indeed from any other known deposits of the mineral, and the deposit is of later geological age. The Great Dyke chromite can be hand-picked to yield a product containing 50 per cent. of chromic oxide, and the quantity available probably amounts to some millions of tons.

Togoland.—A description of deposits of chromite found at Djeti Hill, nine miles south-west of Dadja, on the Lome and Atakpam railway, is given in the Report on the Geology of Western Togoland referred to on page 402. A portion of the eastern side of the hill is composed of massive quartzite. The rest appears to be serpentine, greenish to yellowish in colour, and accompanied by much talc, and here and there common opal in veins. The chromite-bearing area is from 50 to 100 ft. square on the north-eastern slope. Much of the chromite is patchy and mixed with chlorite and serpentine. The serpentine is probably derived from a peridodite, which has been intruded into the schists and quartzites of the crystalline metamorphic series.

German analyses of samples from five prospecting pits gave the following percentage results: chromic oxide, 36·4 to 41·7; silica, 1·8 to 8·7; magnesia, 19·1 to 21; alumina, 18·9 to 23·7; ferrous oxide, 11·8 to 14·9; nickelous oxide, 0·4 to 0·8; with traces of sulphur trioxide and phosphoric anhydride.

The quantity of ore procurable is unknown, but the area is a very restricted one, so that the deposit is not likely to prove of great economic value.

Canada.—According to the *Preliminary Statement on the Mineral Production in the Province of Quebec during* 1920, the production of chromite in Quebec Province amounted to 10,585 tons, valued at $247,730 as compared with 8,148 tons, valued at $223,331 in 1919. The shipments were practically all concentrates of from 45 to over 50 per cent. of chromic oxide.

Prices in the first half of the year varied between 70 cents and $1·00 a gross ton unit for ore containing not less than 50 per cent. chromic oxide, but diminished considerably during the second half of the year. In February 1921 the New York quotations were 50 to 55 cents a gross ton unit f.o.b., Atlantic ports for 50 per cent. ore. A signi-

ficant point in the chromite situation is that for the six months from June to November 1919, Southern Rhodesia produced 9,662 long tons of chromite, and for the corresponding months of 1920 as much as 39,589 tons. It is considered that this large output may adversely affect the Quebec chromite industry.

New Caledonia.—According to a report of T. D. Dunlop, H.B.M. Consul at Noumea, New Caledonia (*The Engineer*, September 9, 1921), the only producing mine in the Colony at present is the well-known Tiebaghi mine at Paagoumene on the northern coast.

Up to February 1921 this mine has yielded 727,000 metric tons of high-grade ore. Several mines at Coulee, near Noumea, have been closed, owing to the fact that the principal customer, the United States, became overstocked in 1920. The ore from these mines requires dressing to bring it up to 50 per cent. grade.

At the Lucky Hit mine at Plum, twelve miles from Noumea, and at the Anna Madeleine mine at Carenage, Prony Bay, thirty miles south of Noumea, about 6,500 tons of ore are ready for shipment.

The Société Le Nickel proposes to manufacture ferro-chromium as well as ferro-nickel at Yate, on the east coast, where they have installed a hydro-electric plant.

The Vercingetorix mine at Unia on the east coast, sixty-three miles from Noumea, between 1913 and 1919 yielded 60,000 tons of ore, averaging 53 per cent. of chromic oxide, but is now exhausted.

Several small deposits on Belep Island, twenty-five miles to the north of New Caledonia, are being worked, and yield a product containing, after dressing, 60 per cent. of chromic oxide.

The exports for 1921 are expected to be quite small, owing to the heavy shipments to the United States in 1920, and the reduced demand due to depression in the steel and other chromium-using industries.

The exports in 1920 were as follows:

To	Metric tons.
United States	87,288
United Kingdom	1,991
Belgium	1,676
Japan	508
France	133
Total	91,596

Coal

United Kingdom.—Wickham King, in a paper on "The Plexography of South Staffordshire in Avonian Time,"

read at a recent meeting of the South Staffordshire and Warwickshire Institute of Mining Engineers (abs. *Colliery Guardian*, August 5, 1921, p. 375), regards the Malvern ridges, created after the coals were laid down in the Stour Valley, and at or about the Blythe Valley, as of vast importance in the search for concealed coal in the Midlands. He considers that to prospect for coals south of an east-to-west line through Stourbridge is foredoomed to failure, unless the speculation is confined to the parts constituting the complicated troughs on each side of the Stour ridge, as south of the line denudation has removed the coals from off the ridge. Coal might possibly be found farther north, between Kingswinford and Enville, away from the troughs on each side, for it may be presumed that, on the ridge, only parts of the pre-Triassic measures have been denuded.

It is thought that in localities where the detrital Permian and Carboniferous deposits are coarse—as near Clent Hills—a boring for coal will be a failure, as the old Charnian and denuded Malvernian ridges are close by. If the boring is made north of Wolverhampton, rich and less fractured seams will probably be found, but the greater depth and water difficulties may make progress slow; whilst in the old Charnian syncline to the south-east, provided the boring is not made too close to the coarser areas of breccias and conglomerates, coals of good quality, but more faulted, may be found at increasingly less depths; and it follows that there are places in both the Stour and Blythe valleys, where the Trias rests directly on the productive coal measures, as at Cannock Chase.

Yugo-Slavia.—D. A. Wray, in his Report on the Geology of this State (see p. 400), states that the most important coal mines are in the Save Valley in Slovenia, where a series of brown-black coals of Oligocene age are extensively mined at several large collieries. In the Trbovlje district, which has an annual production of about one million metric tons, the main seam has an average thickness of 79 ft. The hydraulic or flushing system of filling is used in the Trbovlje colliery. The seam at Zagorje is 98 ft. thick. Glance coal of similar age is worked at Celje. At Kocevlje, brown coal of Upper Tertiary age occurs in a basin-shaped hollow, or "dolina," in the Triassic limestone plateau. There are several seams being worked from 20 to 46 ft. thick. At Velenje, lignite of Pliocene age has in places an enormous thickness, but it is somewhat low in calorific power.

The Zenitsa-Sarajevo coal-field is the most important one of Bosnia. At Zenitsa, the present workings are in No. 3 seam (thickness 24 ft.), but No. 5 seam, of similar

thickness, will be mined in the immediate future. At Kreka, the principal bed of brown coal (Pliocene) is about 66 ft. thick. At the Uglyevik mine, in the important coal-field of the same name (Tertiary brown coal), the principal seam, 66 ft. in thickness, is being worked out in terraces (open-cast).

The Senje, or Senski Rudnik coal mines are the most important in Serbia. The main seam (Tertiary brown coal) is from 33 to 131 ft. in thickness. The Alexinats coal mines, in the Morava Valley, are also of importance. The coal is described as sub-bituminous. The seàms are interbedded with highly bituminous shales.

The approximate annual output of coal from Yugo-Slavia, prior to the war, was three million metric tons, practically the whole of which was used in the State itself. The output in 1919 was approximately 2,500,000 tons.

The probable coal reserves amount to approximately 1,900,000,000 tons, of which 90 per cent. belong to Bosnia and Herzegovina, 6 per cent. to Slovenia, 3 per cent. to Serbia, and the remainder to Croatia, Slavonia and Dalmatia. The possible reserves included in areas not fully investigated amount to approximately 2,364,000,000 metric tons.

The heating power of the Tertiary coals of Yugo-Slavia varies from 3,369 to 7,700 calories, the former representing lignitic and the latter glance coal.

Copper

United Kingdom.—In *Mem. Geol. Surv., Scotland, No.* 17 *of Special Reports on the Mineral Resources of Great Britain*, 1921, p. 148, John S. Flett describes the occurrence of copper in Shetland. The formation is Old Red Sandstone (Lower Carboniferous) consisting principally of conglomerates, red sandstone and shales, with occasionally thin-bedded grey flagstones like those of Orkney. The Sandlodge Mine is on the east coast of Shetland, about fourteen miles south of Lerwick. The main vein trends N. 10° E. in reddish sandstone.

There are said to be two wide lodes, one of which has been proved to a depth of about 300 ft. Oxidised ores, including malachite, melaconite, limonite and hæmatite, occur to a depth of 100 ft. (water level). Below this, the filling consists of pyrite and chalcopyrite, in stringers and nests, in a white gangue of carbonate of lime, magnesia and iron.

The mine was opened about the end of the eighteenth century; shafts were sunk, and about £2,000 worth of copper ore was raised, after which the workings were

abandoned. The mine was reopened in 1872, and it is estimated that in the following eight years 10,000 tons of iron and copper ore were raised. An inclined shaft was sunk on the vein to a depth of 180 ft., and most of the material above the 100-ft. level was removed, but large reserves of ore were left below that level. Nothing further was done until 1920, when active development started.

Both pumping and crushing machinery have been erected, as well as an electrolytic plant (*Metal Industry*, August 19, 1921), but it is understood that operations at the mine and works ceased in October 1921, no doubt largely owing to the low price of copper.

Yugo-Slavia.—The copper mines at Majdanpek and Bor, in this State, are described by D. A. Wray in the Report referred to on page 400. Majdanpek is eleven miles distant from the port of Milanovats on the Danube, with which it is connected by a ropeway (Bleichert system) The ore occurs in masses, as impregnations or as veins at the contact of volcanic rocks with limestones or crystalline schists, and, occasionally, in andesites, where they have been altered or propylitised. Chalcopyrite, the dominant mineral, is associated with pyrite, bornite, covellite, and chalcocite in a quartz gangue. The chalcopyrite frequently forms entire stockworks. The yield of copper varies from 0·3 to 12 per cent., and usually ranges from 2 to 8 per cent. The Blanchard group of workings are the most important of the mine. The length is 4,240 ft., and the total depth 1,555 ft. The vein at one place is 426 ft. in width, and the average yield has been 3·06 per cent. of copper. In twenty years preceding 1890 the production of copper was 2,419 metric tons. Only reconstruction work is at present being carried out, but it is hoped the mines will soon resume operations.

The mines of Bor, seventeen miles N.W. of Zayechar, are now being worked by the Compagnie Française des Mines de Bor. There are five principal veins from 150 to 490 ft. in thickness, and from 1,200 to 1,800 ft. apart. They strike N.S. and dip E. 60° to 70°, at the contact of altered and unaltered andesites, or in the altered andesites. The principal workings are at Chuka Dulkan, where the ore occurs as a huge lens of pyrite, chalcopyrite and chalcocite. It has been proved to a depth of 330 ft., and for a length of 820 ft. The average width is 80 ft. The copper ores, averaging 7 per cent. of copper, are smelted at the adjoining works. Before the war, the output had reached between 7,000 and 8,000 tons. The amount raised during the war is not known, but the output of 1917 alone has been estimated at probably 30,000 tons.

Diamonds

Rhodesia.—Reference to the gem-bearing gravels of the Somabula Forest has already been made in this BULLETIN (1918, **16**, 461). An account of the geology of these gravels has now been given by A. M. Macgregor, with notes by the late A. E. V. Zealley in *Bulletin No.* 8, 1921, *Southern Rhodesia Geol. Survey.*

Diamonds were first discovered near Gwelo, Southern Rhodesia, in 1903. From 1905 to 1908, a company worked the deposits and extracted diamonds to the value of upwards of £25,000, which, however, did not cover expenses. The area was then thrown open to prospectors. The output from 1910 to 1920 inclusive amounted to 13,409 carats, of value about £62,000. At present only about a dozen diggers are working in the field.

The Somabula beds are a series of fluviatile and estuarine deposits characterised by beds of gravel or shingle with well-rounded pebbles. At the bottom is a " wash," or pay-gravel, containing a large proportion of rounded crystals of hard and heavy minerals, the most abundant being staurolite or " blacks," the chief indicator of the diamond; other minerals associated with the diamond are garnet, tourmaline, kyanite, rutile, topaz, corundum (including ruby and sapphire), beryl and chrysoberyl. The beds are in two groups: a newer arkose group, consisting of coarse red felspathic sandstones and gravels, 120 ft. in maximum thickness, and an older mudstone group of fine, pink sandstones and mudstones with gravels, 60 ft. thick (maximum). The beds belong to the Karoo (Stormberg) system. Certain fossils from the region, examined by A. C. Seward and R. E. Holttum, seem to point to these particular beds being of Upper Triassic age. They lie unconformably on ancient gneissic granite. Macgregor concludes that the Somabula gravels were probably brought down by a river rising at least 200 miles to the north of Willoughby's—twelve miles south-west of Gwelo—and including in its drainage area the country to the east.

Gold

Australia.—A description of the mining geology of Kookynie, Niagara and Tampa, North Coolgardie Goldfield, Western Australia, by J. T. Jutson, is given in *Bulletin No.* 78, 1921, *Western Austr. Geol. Survey.* The rocks of the area are almost entirely of igneous origin, varying in composition from moderately basic to highly acid. As in other parts of Western Australia, many of the

lodes occur close to the junction of an acid and a basic rock (*e.g.* granite and greenstone, gneiss and greenstone). The most important quartz reef of the whole district—the Cosmopolitan of Kookynie—traverses a biotite-microcline granite. The strike is N. to S., the dip is E., and the pitch of the shoot is to the south. The mine has been proved to a vertical depth of over 1,000 ft., but it is no longer being worked. From 1898 to 1917 the production was 265,277 oz. from 544,541 tons of ore, or a yield of about 9¾ dwt. per ton. The reef of the Altona mine in the same district is in granodiorite, closely related to a hornblende-granite. The quartz contains much pyrite. The depth is 360 ft. From 1900 to 1917, 13,820 oz. of gold were obtained from 13,643 tons of ore, or a yield of upwards of 20 dwt. per ton.

The Orion lode at Niagara strikes N. 80° E., dips S. from 45° to 75° (average 50°), and is from a few inches to 8 ft. in thickness. The gold is mostly confined to a thin band (" scab ") on one wall, or is inside the lode, parallel thereto, being associated with bismuthinite, chlorite, ankerite, pyrite, tetradymite and calcite. The shoot of ore pitches east. The country-rock is basic-igneous of the greenstone type, and may be described as consisting of amphibolites and epidiorites derived from gabbros and dolerites. The mine is 600 ft. in depth, but it has not been worked in recent years. From 1900 to 1915 gold to the amount of 19,050 oz. was raised from 36,960 tons of ore, a yield of about 10 dwt. per ton.

The peculiarity about the May Lease at Niagara is that, at a certain depth, the lode flattens considerably, and increases in thickness; moreover, the thick flat portions carry the most gold.

The reef of the Grafton mine, at Tampa, is in a rhyolitic quartz-porphyry, which forms a narrow belt in greenstone. The lode is a compound one, consisting of two quartz reefs, which strike N.W. and dip S.W., and vary in thickness from a few inches to about 2 ft.

The total production of gold from the Niagara district (not including alluvial, dollied and specimen gold) amounts to 496,844 oz. from 895,923 tons of ore, or a yield of rather more than 11 dwt. per ton crushed.

Yugo-Slavia.—D. A. Wray in the Report referred to on page 400 states that auriferous quartz veins are found in the old Saint Anne mines on the slopes of Rusman Hill in North-Eastern Serbia. The country-rock is serpentine, or altered gabbro, in close association with intrusive andesites. Pyrite occurs with the gold. Mixed concentrate carries as much as 7 oz. of gold per metric ton, in

addition to much silver. Auriferous quartz veins also occur at the Blagojef Kamen mines. At St. Barbe, the principal mine, the gold is associated with pyrite, chalcopyrite and galena. The thickness of the main vein ranges from 10 to 20 ft. Assays vary from 1·3 oz. of gold per metric ton in the highest levels to 0·6 oz. in the lower levels. The country-rock consists of mica and chlorite schists near trachytic and andesitic masses.

There are various deposits of auriferous gravels in Eastern Serbia, the principal ones being in the Pek Valley, where several dredges were working a few years ago. A number of trials were made recently by the Serbian Mining Department. The best results were obtained between Blagojef Kamen and Debeli Lug, a stretch of gravels of about six miles, lying to the west of Majdanpek. These showed a gold content likely to repay methodical working. Transport is difficult, however. From the whole of the trials it is estimated that from about 4·6 lb. of concentrate the yield was 32 grains of gold. Auriferous gravels also occur in the Bela Reka, Timok and Porecka valleys. The average yield of 150 trial holes in Bela Reka was 1·9 dwt. of gold per cub. metre. The lower Timok Valley gave a similar result. The results of trials in the Porecka Valley were not sufficiently favourable to warrant extensive dredging.

Nicaragua.—The Piz Piz gold district of Nicaragua, at the north-east of that republic, has been described by Robert Hawxhurst, Jr. (*Min. and Sci. Press*, March 12, 1921, p. 353). The formation consists of andesite and diorite. The principal system of veins strikes N. 45° E. or parallel to the more prominent mountain ridges. The veins are from 10 to 25 ft. in thickness, and dip N.W. 25° to 75°. As a rule the walls are well defined, and carry a thin selvage. The gangue is quartz and silicified andesite country; veinlets of secondary calcite are numerous and rhodochrosite occurs in thin seams. Mixed carbonates of iron, calcium and magnesium are present, and oxides of iron and manganese are plentiful in the oxidised zone. The sulphides are pyrite, marcasite, chalcopyrite, galena, blende and bornite (rare), which occur massive, in banded form or in scattered bunches. Gold and silver in a finely divided state are associated with all the sulphides, especially with blende and galena. A fairly representative sample of ore assayed: gold, 0·45 oz., and silver, 6·98 oz. per ton; zinc, 1·31, and lead, 0·12 per cent.

The sulphide enrichment zone averages 200 ft. in depth from surface; below this depth is primary ore, which has no economic value. The veins are probably of late

Tertiary age, and were formed at shallow depth by hot solutions rising in fissures, subsequent to a period of igneous activity.

Gypsum

Canada.—The *Chemical Trades Journal* of August 6, 1921, notes that in drilling recently through salt beds near Fort McMurry, Athabasca River country, about 100 ft. of gypsum and anhydrite of commercial quality were found at 500–600 ft. from the surface. It was not hitherto known to occur so far north, and may be developed if a market can be found.

Australia.—Deposits of gypsum are very widely distributed throughout South Australia, many being of exceptional size and purity, and are everywhere associated with salt deposits (*Bulletin No.* 8, *Geol. Surv.*, *S. Austr.*). The main economic deposits, which are four in number, are situate on the seaboard. The author considers that, although much of the gypsum may have resulted from the conversion of pyrites into sulphate of iron and the subsequent reaction of this with limestone, and some may result from evaporation of sea-water according to the "bar" theory of Ochsenius, the bulk is due, as in the case of salt, to the accumulation of "cyclic" gypsum, which has been dissolved and carried to evaporating areas by saline ground-waters, ultimately being wind-blown into dunes fringing the lakes. There are two factories making plaster of Paris in the State, and much raw gypsum is exported.

Iron

Union of South Africa.—A deposit of hæmatite ore, which occurs in the Rustenburg District, Transvaal, has already been described in this BULLETIN (1920, **18**, 88). It was at that time believed to be a sedimentary iron ore, representing exceptionally rich portions of banded ironstones, but P. A. Wagner (*Trans. Geol. Soc., South Africa*, 1921, **23**, 118), after a detailed examination of the district, has come to the conclusion that the hæmatite deposits owe their origin to a process of secondary enrichment, whereby the original siliceous layers of certain sections of the banded ironstones have been replaced by iron oxide, giving rise to solid bodies of ore made up of alternations of primary and secondary hæmatite layers. In this respect they are of identical origin with some Lake Superior hæmatite deposits. The Rustenburg deposits overlie dolomite, and are overlaid by a bed of chert-conglomerate.

Many million tons probably average not less than 40 per cent. of iron, but the high silica content destroys their value as potential ores of iron. However, lenticular and irregular tabular bodies of high-grade ore occur, associated with the ironstone, from a few inches to 51 ft. in thickness, and from a few yards up to 1,000 yards in length. The two main horizons containing the hæmatite deposits occur near the contact with chert-conglomerate, and also near the contact with the dolomite, and the lower portion of the former has in one place been replaced by hæmatite, giving rise to a small irregular deposit of that ore. Analyses show the ore to be of high grade, containing from 60 to 67·75 per cent. of iron, from 0·55 to 6·32 per cent. of silica, from 0·006 to 0·05 per cent. of phosphorus, and no sulphur.

Canada.—In the *Canadian Mining Journal* of August 19, 1921, some interesting particulars are supplied of the hæmatite deposit on Fenwick Mountain, East Kootenay, within five miles of Wardner, a station on the Crow's Nest branch of the Canadian Pacific Railway. This deposit, which is the largest of the known hæmatite deposits of British Columbia, consists of surface exposures covering an area of about 400 acres on the mountain. The ore-bearing zone is banded, the bands of ores varying from 2 to 8 ft. in thickness, and being separated either by barren or low-grade partings, 6 in.–1 ft. thick. The bands of ore are continuous in length, and do not suggest that they are merely lenses. The ore is of three kinds, viz. a hard blue hæmatite, a slightly schistose ore, and a soft surface ore. A series of samples taken from all the claims had the following average percentage composition: iron, 61·35; alumina, 8·58; lime, 1·56; magnesia, 1·10; sulphur, 0·062; phosphorus, 0·0282; and residue, 8·58. Much of the ore is available for open working. A small amount of development has been carried out, which has proved the surface portion of the deposits, but not their extent in depth, which is believed to be considerable.

In the same issue of the above journal it is reported that a large deposit of hæmatite has been located about sixty-seven miles north of Spragge, and about one hundred miles from Sault Ste. Marie. This deposit was first noted in 1857 by the Herrick Survey expedition, but it was not re-discovered until recently.

Yugo-Slavia.—In his *Report* on the Geology of this State (see p. 400), D. A. Wray states that the principal iron-ore districts are Vares and Ljubia, both in Bosnia. The ores consist mainly of siderites, together with limonites and hæmatites, which have resulted from their alteration.

The iron industry at Vares was founded in 1846 by a Turkish pasha, and numerous primitive furnaces and water-driven hammers, known collectively as *majdans*, are relics of the former activities of the Turks. The ore occurs in a number of irregular lenses in Muschelkalk limestone and dolomite (Triassic). Red hæmatite is mainly exposed in the higher workings, but in depth it passes insensibly into siderite. Poechite, a variety of hæmatite rich in manganese (up to 12 per cent.), occurs in pockets in the hæmatite. The iron content of the ore ranges from 38 to 65 per cent. There are two blast furnaces at Krapuli.

At Ljubia, siderite and limonite occur in three main beds in shales, sandstones and thin limestones of Carboniferous age. The ore is from 200 to 330 ft. thick. The bed extends southward, and covers an area of about 15½ sq. miles. The mine was started by the Austrian Government in 1917, the output being about 1,000 metric tons per day. The ore was worked open-cast, the power for transport and lighting being supplied by a 14,000 h.p. electric plant, which was left intact on the Austrian retreat. Preparations are being made by the Bosnian Government to reopen the mines. It is proposed to erect blast furnaces.

France.—A report issued by the St. Nazaire Chamber of Commerce, an abstract of which appears in *Iron and Coal Trades Review* (July 29, 1921), refers to the considerable iron-ore deposits of Brittany, of which little is generally known. They have now assumed some importance to the United Kingdom from the fact that it is suggested that Breton iron ore might be exchanged for British coal, and thus furnish the boats acting as colliers with a return freight.

The principal deposits are situated (1) in the Châteaubriant Basin, where the ore contains on an average 45 per cent. of iron and 15 per cent. of silica, and (2) in what is known as the middle fold of Brittany, where an excellent magnetite deposit is found in the Forest of Lorges, containing from 50 to 57 per cent. of metallic iron, 6 to 10 per cent. of silica, and 3·5 per cent. of lime.

The extent of these deposits has not yet been defined ; estimates of quantity range from 30,000,000 to 150,000,000 tons of ore. The present monthly production of the iron ores in Brittany averages about 13,000 tons, of which a considerable proportion is exported. So long as the comparatively easily-treated ores of Lorraine are available, the exploitation of the Brittany iron ores on a larger scale is not considered probable. Notwithstanding their greater richness in iron, the additional coke and lime necessary in

their reduction makes them less profitable to smelt than the lower grade Lorraine ores.

Lead

Union of South Africa.—In the *Chem. Eng. and Min. Rev.*, June 5, 1921, E. M. Weston calls attention to the promising character of argentiferous lead and other deposits in the vicinity of Argent Siding, about fifty miles from Pretoria, and between that place and the Middleburg coal-fields.

The mineralised area consists of the Pretoria series of shales and quartzites in which fissure lodes occur in or near the contact of the shales with dolerite dykes. There appears to be an area about seven miles long, traversed by four parallel veins, of which upwards of four miles have been proved to be ore-bearing. These were examined twenty-eight years ago, but lack of communication and of the requisite metallurgical experience, combined with water difficulties, prevented development. A company has recently acquired the area, and development is proceeding. The mine dump of 33,600 tons of ore contains 1,447 tons of lead and 226,000 oz. of silver, and another dump of 30,000 tons of jig tailings assays 3½ per cent. of lead and 5·7 oz. of silver per ton. The reserves are estimated at 80,000 tons of ore, with 15 to 25 per cent. of lead, and 15 to 25 oz. of silver to the ton. Analyses of a large number of samples have confirmed these estimates. Preparations have been made for the erection of a plant with an annual capacity of about 50,000 tons, and of another for regrinding the jig tailings.

The area over which the ore is found is considered to be sufficiently large and rich to compensate, by its development, for the decline in gold mining.

Yugo-Slavia.—A description of the lead-zinc mines of this State is given in D. A. Wray's *Report* referred to on page 400. The important lead mines of Misitsa (or Meiss) are eleven miles S.E. of the small town of Pliberg, in Northern Slovenia. The workings date from the fifteenth century. Galena and wulfenite are the principal ores, and occur mainly in veins, in zones of local brecciation, and in crevices or gash-veins—in the limestones, enlarged by solution. The lead ores are associated with blende, smithsonite, pyrite and marcasite, while the gangue minerals include quartz, calcite, a little fluorspar and barytes in a vein-filling of fragmental limestone and brown clayey matter. There are ten main levels, the deepest one being 2,900 ft. from the surface. From 1914 to 1918 inclusive

the yield of metallic lead amounted to 45,256 metric tons. The mine owns a large dressing plant and smelting works.

There are lead-smelting works at Litija and zinc-smelting works at Celje.

Srebrenitsa, Eastern Bosnia, was an important lead and silver mine in Roman times, and was reopened in the Middle Ages. The veins carry argentiferous galena and blende, and strike N.N.E. in Palæozoic limestone and sandstone, near large intrusive masses of trachytes and propylites. Here and there the principal filling is blende, which predominates also in the lower levels. The mines were worked from 1915 to 1917, producing 982 metric tons of lead ore. Production ceased in 1918.

Extensive slag-heaps are found in the Kosmaj lead mines. In 1910 and 1911 nearly 3,000 metric tons of pig-lead were obtained from the slag dumps of the Babe mines, which are reported to have been worked by the Romans 2,000 years ago. The ancient slags, worked over during the war, are said to contain from 6 to 7 per cent. of lead.

The Kucajna lead and zinc mines were worked by an English company from 1873 to 1893, during which period they yielded 140,000 tons of zinc ores, and 270,000 tons of lead ores carrying 2,005 oz. of gold and 39,015 oz. of silver. A disastrous fire destroyed all the surface plant in 1893, and since that time only exploratory work has been undertaken. The veins strike N. to S. in Cretaceous limestone, near quartz-andesite or dacite intrusions. Besides galena (rich in gold and silver) and blende, auriferous pyrite, cerussite, smithsonite, hemimorphite, and auriferous limonite occur with small quantities of chalcopyrite, bornite and arsenopyrite. The precious metals increase with the proportion of quartz, and decrease with an increased proportion of blende and pyrite in the lodes.

The Kratovo lead mines of Macedonia have been worked intermittently from the Middle Ages, and were last worked by Austrian engineers during the Turkish occupation of Macedonia. Galena occurs in calcite veins in limestones and crystalline rocks in close proximity to extensive intrusions of trachytes, rhyolites and dacites. The veins vary from 3 to 12 ft. in thickness. Near Dobrovo, the lead ore is associated with rhodochrosite, pyrolusite, malachite, siderite and barytes, and at Dugi Hrid a little blende appears with the galena.

Manganese

Hungary.—According to an article in *Stahl und Eisen*, an abstract of which appears in *Min. Journ.* (Sept. 3,

1921) a discovery of manganese ore deposits made in Hungary in 1917 is of considerable importance. The deposits are situated about fifteen miles north of Plattensee in West Hungary, near the towns of Nagyvazsony and Urkut. The basic rocks of the district are Lias limestones, in which the manganese ore occurs as a metasomatic deposit, and also as a secondary deposit. Both classes of deposit, with some clay, occupy pockets in the limestone.

The primary deposit lies immediately on the Red Lias limestone, and is in two layers, one of which is from 8 in. to 2 ft. in thickness, and the other from 5 ft. to 10 ft. Between these is a layer of soft marl about 2 ft. thick. The area of the primary deposit is approximately 15,000 square yards.

The secondary deposit is estimated to cover an area of 70,000 square yards. Most of the ore varies in size from small grains to nodules of 20 to 40 lb.; but occasionally it is in very large pieces. The ore is mainly psilomelane, but pure pyrolusite is also found. The thickness of the deposit varies from 9 to 70 ft., and much of it lies quite near the surface. Experiments have shown that washing produces a clean concentrate assaying about 50 per cent. of manganese. There is estimated to be a recoverable amount of 400,000 tons of concentrate in the deposit so far as it has been prospected. Other deposits of a secondary character outcrop in the vicinity, but these have not been examined thoroughly.

The two classes of ore have been analysed with the following percentage results:

	Manganese (Mn)	Iron (Fe)	Silica (SiO_2)	Magnesia (MgO)	Phosphorus (P)
(1)	42 to 52	2 to 4	2 to 7	1·7 to 1·8	0·10 to 0·21
(2)	35 to 37·5	5 to 8	11 to 20	1·8 to 1·9	0·12 to 0·18

Yugo-Slavia.—According to D. A. Wray (cf. p. 400) the Cevljanovits manganese mines are situated 15½ miles south of Sarajevo in Central Bosnia. The ores consist mainly of psilomelane, in intimate association with barytes (5 to 6 per cent.), as impregnations and veins in Jurassic radiolarian cherts. The cherts are generally too siliceous to repay extraction, and practically the whole of the ore is now mined in the contemporaneous argillaceous beds, in which it occurs in the form of nests and lenticles. The ore-bearing beds, most probably of sedimentary origin, extend over an area of 8 by 4 miles. The mines were worked by the Bosnian Provincial Government from 1880 until October 1918, when operations ceased. Before the

war the average annual output was 4,000 tons. In 1916 and 1917 it reached 22,674 and 48,851 metric tons respectively.

Brazil.—Horace E. Williams, in *Eng, and Min. Journ.* (June 18, 1921, p. 1019) briefly describes the deposits of manganese and graphite which occur near Volta Grande, Minas Geraes, Brazil. The outcrop is traceable for over two miles from the Rio Angu to Bella Vista, parallel to the Rio Parahyba, and from four to five miles E.S.E. of the Volta Grande railway station. Psilomelane and graphite occur together in these deposits, but along the hill-tops and sides the former is by far the more abundant, and graphite, with a good deal of psilomelane and mica, prevails in the depressions, of which there are four between Rio Angu and Bella Vista. The region is one of comparatively heavy rainfall, the result of which has been the removal of the graphite down the slopes and its deposition in the depressions and adjacent flats. In a cut made above Bella Vista the deposit strikes N. 70° E. and dips N. 60° to 70°, is 6 ft. thick, and consists principally of hard psilomelane and kaolin, with scattered blocks in the decomposed gneiss of the foot-wall over a width of from 6 to 10 ft. In addition, thin irregular sheets of rich tabular ore occur in considerable quantities in the gneiss.

It is highly probable that the large accumulations of surface ore have resulted from the oxidation and hydration of the mineral, which originally consisted largely of carbonates and silicates. With increase in depth, the spongy ore becomes more massive, but decreases in density, there being a perceptible increase in the siliceous and graphitic content.

A good deal of manganese ore was mined here during the war.

Marble

Union of South Africa.—In *South Afr. Min. and Eng. Journ.*, June 18, 1921, an account is given of a large outcrop of serpentinised dolomite, which has recently been discovered near Pretoria. Specimens taken to Johannesburg were of beautiful colour and splendidly "figured," and would be eminently suitable for interior decoration, memorials, etc. There is a very large quantity available, and work has been commenced on the deposit by a company recently formed for the purpose, a new industry being thus inaugurated.

Oil Shale

Union of South Africa.—The oil shales of Underberg, Impendhle County, Natal, were revisited by Alex. L.

Du Toit in November last, who has recently published some additional information with regard to them (*South Afr. Journ. Indust.*, May 1921, p. 346). A good deal of development work has been done recently on the areas at Duart Castle, in the Hlatimbe Valley, and at The Waterfall, in the Umkomaas Valley. On the south side of Duart Castle, oil shale has been proved to be continuous for over a mile in length. The following is a typical section: shale roof; oil shale, 24 in.; shale, 13 in.; oil shale, 9 in.; stony shale, 32 in.; oil shale, 16 in.; fire-clay floor. The material referred to as oil shale is really a variety of coal, in some respects approaching cannel, but black, glossy and somewhat laminated. The total thickness is 4 ft. 1 in., but on Glenara it is about 2 ft.

The Waterfall area is on the south side of the Umkomaas Valley. On the south side of The Waterfall the oil shale shows 3 ft. 6 in. in thickness. Some has a glossy fracture, and some is dull. A sample taken at random gave the following percentages: moisture, 0·7; volatile matter, 3·4; fixed carbon, 39·75; ash, 25·35. The outcrop of oil shale extends along the hillside for fully a quarter of a mile.

A valuable discovery of oil shale is said to have been made recently on the farm Maviriestad, about twenty miles S.E. of Ermelo, Natal (*South Afr. Min. and Eng. Journ.*, July 9, 1921, p. 1443). The strata belong to the Middle Ecca Series, and consist of sandstones, grits, shales and coal seams. About 120 ft. below a coal seam, there is a seam of oil-producing shale from 3 to 6½ ft. thick. It resembles cannel coal in physical features. A sample yielded 20 gallons of crude oil per short ton of shale. Another section gave shaly cannel coal, 2 ft. 8 in.; good oil shale, 2 ft. 8 in.; rough oil shale, 14 in. The good oil shale yielded 28 gallons of crude oil per ton, and the other two each yielded 12 gallons per ton. The oil shale can be worked by adits.

In Griqualand West, it is reported that oil shale has recently been discovered, 8 ft. thick. An area of about 50 acres has been proved by bore-holes to about 100 ft. in depth. Samples yielded 12 gallons of petrol and 40 gallons of strong ammonia per ton (*South Afr. Min. and Eng. Journ.*, July 9, 1921).

Yugo-Slavia.—The oil shales of Serbia are described by D. A. Wray in the *Report* mentioned on p. 400. Oil shales of Lower Miocene age cover an area of about 25 square miles around Valyevo and Lazarevats, in the Kolubara Valley. They consist of white and grey shales forming cliffs 180 ft. above the surrounding plain. The shales, which yield

paraffin on distillation, have probably resulted from the natural distillation of the brown coals so frequent in the Tertiary formation in Serbia. An analysis of these shales yielded: oil, 0·25 per cent.; wax, 1·75 per cent.; and carbonaceous matter, 2·94 per cent. These shales are similar to the oil shales which occur at Alexinats.

Bituminous shales occur in several other localities in Serbia, notably near Oresats, at Janok Stanca, and near Vranje, in the lower Morava Valley.

Petroleum

Egypt.—A preliminary report on the Abu Durba oil area of Western Sinai by W. F. Hume, T. G. Madgwick, F. W. Moon and H. Sadek has appeared recently (*Petroleum Research Bulletin*, 1921, *Ministry of Finance, Egypt*). The oil region is situated on the eastern shores of the Gulf of Suez, 28½ miles N.W. of Tor, 108 miles S.E. of Suez, and 39 miles S.E. of Abu Zeninia. It lies between the southern end of the Abu Durba range (altitude, 1,476 ft.), and the northern end of the Araba range (2,282 ft.), both of which are composed of very hard granite, surrounded by sedimentary rocks. The granites are the oldest rocks, and are well developed, and along their eastern side is the Nubian sandstone, which, in Western Sinai, occurs between the Cretaceous (newer) and granite and metamorphic (older) rocks. The Nubian sandstone is a most important rock from an oil standpoint, and consists of a series of sedimentary rocks, usually ferruginous, of dark-red colour at the base, but becoming nearly colourless at the top. The basal bed is a coarse quartz-conglomerate, well developed in some places. The structure of the Abu Durba range is that of an asymmetrical anticline, of which the long slopes with relatively small dips lie to the eastward. To the west the strata have been highly disturbed, and are hidden either beneath the beach or below actual sea-level.

A considerable area of coarse quartzose Nubian sandstone (from about 1,500 to 2,000 ft. in length, and about 150 ft. in width) is blackened with bituminous matter, which, when newly broken, smells very strongly of petroleum. In a cutting, moist asphalt-like material was observed in the pores of the rock, and along the joints sulphur encrustations were very marked. At two localities on the shore small vents of sulphuretted hydrogen were found, from which sulphur had been slowly deposited, forming mounds of sulphur-cemented sand. Calcite veins were found in the eastern part of the area, these including particles of carbonaceous matter smelling strongly of

petroleum. There is evidence of submarine seepages in the reef area, for, off one point, oil has been noted floating on the surface of the sea.

Bore No. 1 was put down 150 ft. from the nearest surface outcrop of oil-rock. At a depth of 200½ ft. it was stopped in an oil-sand. Indications of oil were met with below 23 ft. At from 140 to 142 ft. an asphalt-like sand was passed through, which gave a total yield of 1,200 gallons (possible yield of three barrels a day). The most important oil horizon was struck between 172 and 185 ft., and the yield on November 14, 1918, was 1 ton of petroleum in twenty-four hours. This quantity has been consistently yielded by pumping since that date, and the oil obtained has been used as fuel for boilers in connection with subsequent operations. The sample of oil was black in colour; specific gravity at 60° F., 0·973; flash point (close test), 168° F.; fraction distilling below 290° C., 15·6 per cent.; asphalt, 8·8 per cent. By distillation the sample yielded the following percentages of constituents: kerosene, 3·7; gas oil (solar oil), 11·9; residue (fuel oil), 83·5; water, 0·9.

Prospect Bore No. 2 was sunk at a point 250 ft. farther down the slope from the outcrop of oil-rock, and was carried to 545 ft., when it was stopped in apparently decomposed igneous rock. Oil sands were encountered at from 182 to 194 ft., oil from 241 to 246 ft., at 294 ft. and at 462 ft.

Prospect Bore No. 3 was put down on the same strike-line as No. 1, and 164 ft. from it. The best indications of petroleum were at 143 ft., the yield being one barrel in twenty-four hours.

All the samples taken appear to be oils from which the light products have evaporated, and a waxy resin (an oxidation-product of paraffin wax) is present in them all, which indicates that the oils are inspissated and oxygenated products of petroleum.

In view of the slight improvement shown by the oil obtained at the greater depths, and the persistent yield from No. 1, it is proposed to explore the limits of the field by further boring operations.

Canada.—The oil struck in October 1920 in a well (now known as the Discovery well) at Fort Norman, North-West Territories, was referred to in this BULLETIN (1920, **18**, 458), and a short account of the geological structure of the region was given in a subsequent number (1921, **19**, 103). Further information is contained in a report on the oil-bearing rocks of Lower Mackenzie River valley by E. M. Kindle and T. O. Bosworth, which has

appeared recently (*Canada Geol. Survey Summary Rept. for* 1920, *Part B*, p. 37).

After giving particulars of location, transportation, climate, geography, stratigraphy and structure, the authors state that, so far, no oil has been detected within the beds of the bitüminous Beavertail limestone of the Middle Devonian, and no oil seepages emanate from them, although at depth, under favourable structural conditions, it is possible that some of the beds in this series may be found to hold accumulations of fluid oil. Richly bituminous shales, known as the Fort Creek shales (Upper Devonian), from 500 to 1,000 ft. in thickness, lie above the Beavertail limestone ; fluid oil was not seen in these rocks, and no seepages of oil rise from them. At depth, however, under favourable conditions, it is likely that the sandy beds will carry oil. The present main oil horizon (783 ft.) in the Discovery well is supposed to be within these beds. Above the Fort Creek shales are the Bosworth sandstone and shale (also Upper Devonian), consisting of greenish and vari-coloured clay-shales and sandstones with marine shells and plant fragments, upwards of 2,000 ft. thick. Sandstones containing oil were seen in all the outcrops of the Bosworth beds that were examined. Some of the oil-sands were saturated with oil, which is light and almost colourless, and has an odour indicating a paraffin base and high gasolene content. All the oil seepages discovered arise from sands in these beds. Oil on the surface was found in five different localities. Further search will probably reveal many others. Gas is escaping at all the localities where the oil seepages are found.

It is evident, the authors state, that the conditions conducive to the formation of oil-fields are here very favourably fulfilled. Extending over a large area, there are 1,000 ft. or more of highly bituminous limestones and shales, from which an immense quantity of petroleum might readily be generated, and, overlying these beds, there are 2,000 or 3,000 ft. of clay-shales and sandstones, from which numerous seepages of oil arise. Finally, this mass of petroliferous deposits is traversed by large, bold, anticlinal folds. The high parts of the anticlinal hills are not now territory favourable for oil, since denudation has removed the oil-bearing formations from them. But these main anticlines pitch up and down, and probably in some parts of the low flat land, on the west side of the river, perhaps along the prolongation of these axes of folding, similar great arches of the petroliferous formations may be present underground. Such would be ideal situations for the accumulation of pools of oil. Away

from the crests, the dip slopes of the main anticlines present considerable possibilities, and the minor undulations may prove important. The Discovery oil well is on the flank of one of the large anticlines, eight miles distant from the crest.

The sum of the geological evidence, together with the result of the test well, indicates an extensive oil region in which a number of oil-fields may occur.

Yugo-Slavia.—D. A. Wray, in the *Report* referred to on page 400, states that several parts of this State present apparently favourable conditions for the occurrence of oil, but as yet the only area in which it has been proved in any quantity is Croatia, where the Upper Tertiary beds are extensively developed, and but little disturbed. The first boring was made at Bujavitsa, sixty-two miles south-east of Zagreb, through Pliocene sandstone, limestone and sands. At 1,150 ft. a large yield of gas was encountered; a second gas horizon was struck at 1,283 ft. The boring was discontinued at 1,300 ft., having passed into oil-bearing sands 13 to 16 ft. thick below the gas. The estimated annual yield of gas from the boring is 80,000,000 cubic metres. It is intended to employ this gas for a variety of industrial purposes in the near future. The thick, crude, tarry oil from the oil-bearing sands is being clarified in large tanks. A boring put down about fifty-six miles north-east of Zagreb also yielded gas and oil under similar conditions to the boring at Bujavitsa.

Indications of oil and its allied products have been recorded from the newer Tertiary formations in numerous other localities in Croatia and Slavonia. Between the Dinaric Alps of Western Croatia and the Carpathian Mountains is a great basin (Pannonia) which contains a considerable thickness of Miocene and Pliocene beds. The southern half of this district extends into Croatia and Slavonia. The beds have not been greatly disturbed since their original deposition, but are folded into broad and shallow anticlines and synclines trending N.W. According to Palta, seventeen anticlinal domes occur between the Drave and Save rivers, and conditions appear to favour further explorations.

Asphalt limestones have been worked for upwards of a century in Dalmatia, and asphaltic limestones and asphalt are found in several other parts of Yugo-Slavia.

Phosphate

Japan.—An abstract in *Journ. Soc. Chem. Indust.* (1921, **40,** 216 R.) from the *Japan Times* states that a deposit of

phosphate, superficially estimated to contain 15,000,000 tons, has been discovered on a hitherto unknown island lying south of Rasa Island. Development work has been commenced.

Salt

India.—An account of the Rajputana salt industry by P. C. Scott O'Connor is published in the *Journal of Indian Industries and Labour* (1921, **1**, 129). The principal source of the salt is Sambhar salt-lake, the largest of its kind in India, being about twenty miles long and two to seven miles wide. The lake is thought to have originated by the concentration of brine, formed by salt, wind-blown from the sea, becoming dissolved in rain-water (Holland: *Rec. Geol. Survey India,* 1909), and the supply of salt is being added to annually in this manner.

The extraction of salt at the lake is done by manual labour, and, if begun at the right time and all dirt and insoluble matter picked or washed out, salt may be obtained containing 99 per cent. of sodium chloride. Steps are being taken to introduce machinery and modern methods, so that a great increase in the production can be effected as soon as possible in order that the necessity for importing foreign salt into India may be reduced.

Australia.—In *Bulletin No.* 8, *Geol. Survey, S. Australia,* will be found a detailed account by R. Lockhart Jack of the salt deposits of South Australia. Owing to the low annual rainfall and consequent lack of run-off, the high evaporation, and the presence of numerous basins of internal drainage, salt is very widely distributed in South Australia. Since rock-salt has not yet been found in the State, it appears most probable that the accumulations of salt may be due to "cyclic" salt, or salt in the form of dust in the air, which has been washed out by rain, and which normally completes the "cycle" by returning to the sea in the drainage of the land. This salt, the 1920 crop of which the author estimated to exceed 300,000 tons, is harvested annually from the "pans," or salt lakes, which contain salt either as a crust or as brine saturating the lake bed. It is collected generally by scraping and shovelling into carts. Seven refineries were in operation in the State in 1920. There are also two companies producing salt by solar evaporation of sea-water. Apart from that salt which is harvested annually, there is estimated to be 15,000,000 tons of salt accumulated in the three main lakes alone.

Silver

Canada.—The silver deposits at Stump Lake, British Columbia, are described by Charles Cansell in a recently published report (*Canada Geol. Survey Summ. Report for* 1919, p. 35 B).

Stump Lake is south of Kamloops Lake in the Nicola Mining Division of Yale District. The mines were practically abandoned for about thirty years, but have recently been reopened. The deposits consist of quartz veins from 10 in. to 5 ft. in thickness, containing pyrite, chalcopyrite, galena, blende, jamesonite and tetrahedrite, and traversing a dark green dolerite-porphyrite. The veins strike from N. 20° W. to N. 15° E., and have been traced on the surface for several hundred feet. In one claim the vein is 4 ft. in thickness, with pay-streaks from 4 to 18 in. thick on either wall, and is worth from $50 to $100 per ton for the silver it contains. The gold contents vary from 3 to 5 dwt. per ton. The remainder of the vein is concentrating ore of much lower grade. Where the veins are rich in tetrahedrite they may carry up to 400 oz. of silver per ton.

The Salmon River District in the Portland Canal Mining Division, British Columbia, is described by S. J. Schofield and George Hanson (*Canada Geol. Survey Summ. Report for* 1920, p. 6 A), completing the study of the geology and ore deposits in the district commenced by J. J. O'Neill (*Summ. Report*, 1919, p. 7 B).

The district is about 60 square miles in area; low grade complex ore was discovered in it in 1904, and high grade silver ore proper, a few years ago. At the principal mine, the Premier, already briefly described in this BULLETIN (1921, **19**, 126), sill-like masses of quartz porphyry are intruded between the bedding-planes of the tuffs of the Bear River formation (Upper Jurassic). The ore-bodies occur principally in the tuff porphyry contact. The ore shoots are in the form of lenticular veins, in most places about 10 ft. in thickness. They have been formed partly by fissure filling and partly by replacement of the country-rock. The wall-rocks have been intensely altered, and in most cases extensively silicified. The minerals present are pyrite, chalcopyrite, blende, galena, tetrahedrite, freibergite (argentiferous tetrahedrite), polybasite, pyrargyrite, argentite, stephanite, native silver and gold. The gangue is quartz. The ore-bodies strike N. 75° E. and dip N. 70°, and are cut by several faults and shear zones. The movement along the faults has caused a block of the country-rock to be displaced, so that a portion of the vein is offset

to the south about 40 ft. The native silver is almost entirely associated with these faults and shear zones, and is therefore regarded as due to secondary enrichment. It occurs as thin leaves or plates filling cracks in the ore, or as wire silver and nuggets in small quartz druses.

The Mayo Area, Yukon, is described by W. E. Cockfield (*Canada Geol. Survey Summ. Rept. for* 1919, p. 3 B). There have been recent discoveries of argentiferous galena in this area. The rock on Keno Hill consists of gneissoid-quartzites, quartz-mica-schists and mica-schists, of the Nasina series, cut by a dyke of greenstone, which has been sheared to a considerable extent. The ore deposits are fissure veins occurring both in the dyke and in the surrounding country-rock. One vein strikes N. 10° E. and dips E. 55°, and is from 1 to 6 ft. in thickness, the filling being massive galena, carrying about 150 oz. of silver per ton. Other veins show galena, arsenopyrite, iron carbonates and hydroxides, the gangue being quartz.

A fair amount of development work has been done on the Lookout Mountain. The vein follows an irregular fracture in a gneissoid-quartzite and quartz-mica-schist. The filling consists of manganite, pyrolusite, limonite, cerussite, anglesite, galena and quartz. The ore is of a disseminated character, the galena occurring in small streaks and masses. Five samples, cut across the portion of the ore-body exposed in the workings, gave an average of about 38 oz. of silver per ton, and about 32 per cent. of lead.

In a later report (*Canada, Geol. Surv. Summ. Rept. for* 1920, p. 1 A) Cockfield states there are two systems of faulting with which the veins are bound up, viz. longitudinal faults, parallel to the trend of the formations, and transverse faults which cut across them. The former are mineralised with quartz, arsenopyrite, siderite, manganese, and galena; the latter with quartz, calcite, galena, blende, manganese and siderite, and enriched with freibergite(?). The principal ore shoots lie in the transverse faults. The pure galena from the ore shoots assays from 200 to 2,000 oz. of silver per ton.

United States.—The Silver Horn District, Nevada, described by T. H. M. Crampton in a recent number of the *Min. and Sci. Press* (June 25, 1921, p. 883), is 23 miles north of Pioche, at an altitude of 6,200 ft. The deposit, which is a silver-bearing vein, was first systematically developed early in 1921, but the outcrop, which projects from 10 to 30 ft. in places, was discovered a few years previously. The vein strikes E. to W., dips N. 23°, and is a replacement ore-body from 10 to 200 ft. in width, and

2,000 ft. in length. The hanging-wall is a brown lime-shale, and the foot-wall is a hard, compact, dark-blue limestone. There was extensive movement along the contact, which resulted in the brecciation of both formations. The breccia, generally speaking, was replaced by siliceous solutions, carrying about 5 oz. of silver to the ton, but large masses of the rocks remained unchanged. According to Charles P. Berkey, subsequent deformation and the shattering of a part of the already silicified rock resulted. Later, mineralising solutions furnished a variety of silver minerals, from sulphide at one extreme to horn-silver (cerargyrite) at the other. Shear zones are often in evidence, perpendicular to the strike; they range from 6 to 55 ft. in width, and carry from 15 to 30 oz. of silver per ton.

The Silver Dale Mine, adjoining the Silver Horn on the west, contains an extension of the main vein-system, and is said to show a favourable amount of ore.

The Divide Silver District, south of Tonopah, Nevada, is described by Adolph Knopf in *Bulletin* 715-K, 1921, *U.S. Geological Survey*. The ore deposits are silver-bearing fracture zones or lodes, more or less sheared, in rhyolite breccia of the Siebert formation, which is intruded by later rhyolite and andesite (all Tertiary).

The outcrops are barren of silver, and the first discovery of the principal silver-bearing lode was made in 1917 by cross-cutting at a depth of 165 ft. This lode, which now forms part of the Tonopah Divide Mine, strikes N.W. and is vertical. The walls are well defined, and mark a zone of faulting. The filling consists of rhyolite breccia, carrying disseminated pyrite, and traversed in places by irregular seams or gouges of extremely fine-grained sericite (" talc ") containing visible amounts of cerargyrite (horn silver), and yielding assays running up to several thousand dollars a ton. A few thin veinlets of fine-grained quartz occur in the lode matter in places, but, with this exception, there is an almost complete absence of vein quartz and of silicification. Some soft black pulverulent (" sooty ") argentite has been found in other mines in the district, and probably occurs in the Tonopah Divide Mine. At the point where the lode was first cut in the latter mine, molybdite occurs, giving place to powellite (calcium molybdate) in the level below. Molybdenum minerals have not been noted elsewhere in this mine. The shoot of silver-bearing ore is approximately 400 ft. long, 500 ft. in vertical depth, and 21½ ft. in width. It pitches south at a steep angle, and averages $27·60 a ton. The ratio of gold to silver in weight is as 1 : 200. The ore

reserves in July 1919 were estimated to be 52,000 tons, averaging 20 oz. silver and 0·08 oz. gold per ton. The mine was then 581 ft. in depth. The primary silver ore has not yet been determined.

In the Divide Extension Mine, adjoining the last on the north, a mineralised zone has been cut, which trends N. 10° E. The lode is 40 ft. wide, and carries about 7 ft. in thickness of silver ore on each wall, the filling between being of low grade.

Strontium

Canada.—According to a report published in *Can. Chem. and Met.*, July 1921, a large body of celestite and strontianite has been found on Tidewater, 200 miles north of Vancouver, British Columbia. The deposit is said to be 50 acres in extent. Details are not yet to hand.

Tin

Nigeria.—In *Bulletin No.* 1, 1921, *Geological Survey, Nigeria*, J. D. Falconer, the Director of the Geological Survey, gives an account of the geology of the Plateau tin-fields.

The Nigerian Plateau consists chiefly of ancient granites intruded by a younger granite batholith. Extensive denudation has removed the higher portions of the intrusive body, exposing the older rocks, and the remnants now appear as a series of detached stocks, bosses and dyke-like masses. Numerous dykes—both acid and basic types—are associated with the granites, and these mark a later stage of igneous activity. The younger granites are much broken and fissured, and at some points crush zones resulting from rock movements have been formed. Falconer considers that in some cases the fissures formed a vent for the escape of vapours and solutions from the volcanic focus, indicated by greisenisation, silicification and mineralisation of the fissure walls. He believes that the younger granite as well as the older contact rocks were in places highly mineralised, indications of which are still apparent. The cassiterite in these now denuded areas became concentrated in the stream channels traversing this system, the original concentrations probably having been subjected to many subsequent rearrangements due to changes of level caused by later volcanic action. The granites do not appear to contain cassiterite as a primary constituent, and Falconer believes that the tin is of pneumatolytic origin, and was formerly contained in lodes and mineralised areas in the granites. A mineralised

belt, 4 to 5 miles wide, appears to have extended from near Jos to the vicinity of Kuru, and another belt passed through the Ropps massif in the neighbourhood of the Downs. The older rocks contain small mineralised veins and stringers near the granite margins, and Falconer suggests that careful prospecting might reveal workable lodes, pipes and stockworks. The minerals found *in situ* are mainly cassiterite, topaz and specular hæmatite; wolframite occurs rarely and in one locality only; pyrite, chalcopyrite, arsenopyrite and molybdenite are also found. Tourmaline pegmatites, not stanniferous, are often associated with the older rocks.

South-West Africa.—The cassiterite-bearing areas on Pankwob Mountain were referred to in this BULLETIN (1921, **19**, 252). The following notes on the Pankwob Tin Mine are taken from a report by Owen Letcher (*South Afr. Min. and Eng. Journ.*, May 21, 1921, p. 1151). The mine is situated 45 miles west of the township of Omaru. The formation is described as felsite and granite, rich in tourmaline, and frequently containing visible tetragonal crystals of cassiterite. The lodes, of fissure type, are numerous, and are found on the flanks of the Pankwob Mountain. They strike mostly E.-W., and are crossed by a number of "counter" lodes, and, in one place, a network of veins occurs, forming a stockwork. The occurrences on both sides of the mountain are probably related genetically to the plutonic complex, which is capped by a large dolerite flow, and in places is flanked by slates.

The majority of the lodes may best be termed felsites. Over large areas mica is entirely absent, and the matrix consists of a cryptocrystalline mixture of quartz and felspar. At certain points, muscovite, and occasionally biotite are present, and in these areas the lodes are truly granitic. There are no evidences of any extensive faulting or earth movement where the stanniferous bodies occur. Tourmaline is the predominant mineral; other associated minerals are muscovite, biotite, garnet, fluorspar, chlorite, beryl and molybdenite (rare). Detrital deposits containing tinstone occur both on the eastern and western sides of the mountain, mainly of alluvial and partly of eluvial origin. The thickness of the gravel varies from 2 to 7 ft. One sample assayed 2·53 per cent. of tin. The average of seven samples taken from shallow workings on the lodes yielded about 3 per cent. of tin on an average width of 38½ in.

United States.—The Black Range Tin District of New Mexico is described by Foster S. Naething in *Min. and Sci. Press*, April 23, 1921. Cassiterite occurs both in placers and in small irregular veins and seams through

rhyolite-porphyry in an area which is approximately 200 square miles in extent. The thickness of the veins varies from that of a knife-blade to a few inches. Some branches of ore, 6 in. thick, assayed 30 per cent. of tin. The cassiterite is usually crystallised with hæmatite and magnetite, and, in places, occurs with a little quartz, although the last mineral is generally lacking. The porphyry has been altered on each side of the veins, and part of the felspar has been replaced by iron oxide or by cassiterite. Some of the cassiterite is in the form of brilliant red crystals, which are particularly noticeable in the workings on Squaw Creek. Here two systems of fractures cross one another, and, for a length of 37 ft. in an upper tunnel, the rock (porphyry) carries from 1 to 1·5 per cent. of tin. An area in the Nugget-Gulch, 1,000 ft. long, and several hundred feet wide, is cut by a number of seams and carries 0·1 per cent. of tin.

In Squaw Creek, all the alluvial gravel was found to carry a few tenths per cent. of tin, but the mineral was concentrated only in a narrow channel from 25 to 50 ft. wide and from 3 to 5 ft. deep, which contained from 1 to 1½ lb. of tin per cubic yard. The best gravel was in the first 12 in. above bed-rock.

The stanniferous deposits of New Mexico are evidently very similar to those of old Mexico in the south, especially those at Potrillos, Durango and Sain Alto, Zacatecas, where the country-rock is rhyolite or rhyolite-tuff, and the veins are usually mere stringers, which often intersect, forming little bunches of ore at the junctions, and the concretionary ore is mixed with iron oxides and associated with quartz. Moreover, placer-tin occurs in the same areas as the vein-tin, being found deposited in hollows, cavities and flats in the gullies, etc.

The deposits of New Mexico have been worked on a small scale for a number of years, and some of them have been thoroughly tested, but the output has always remained small, and none of them has warranted the outlay of a large sum for development and erection of plant. Judging by the experience gained in Mexico, it is highly improbable that tin ore will be found in large workable quantities in the rhyolite of New Mexico.

Zinc

Yugo-Slavia.—Reference to the zinc mines of this State is made under the heading " Lead " (p. 414).

NOTICES OF RECENT LITERATURE

COCOA AND CHOCOLATE, THEIR CHEMISTRY AND MANUFACTURE. By R. Whymper. Second Edition. Revised and enlarged. Pp. xxi + 568, 8vo, 10 × 6½. (London: J. & A. Churchill, Ltd., 1921.) Price 42s. net.

The first edition of this work was published in 1912, and was reviewed in this BULLETIN (1912, **10**, 182). The second edition, like the first, is divided into three parts, which deal respectively with (1) the history, botany and agriculture of cocoa, (2) the manufacture of chocolate and cocoa powders, and (3) the chemistry of cocoa, embracing a survey of the components of raw and manufactured cocoa, and of chocolate, and the methods of analysis. Considerable additions have been made to the original work in each of these sections as a result of recent investigations and of the improvements in machinery and in the methods of manufacture. The statistical and analytical tables throughout the work have been brought up to date, and references are given to original communications in recent periodical literature, whilst a full bibliography is quoted at the conclusion.

Owing to the difficulty of procuring adequate supplies of the raw material required for the manufacture of chocolate during the war, very inferior qualities were offered for sale and were readily purchased at enhanced prices. But, with a return to normal times, competition and a fastidious public will again have to be catered for, and the manufacturer can no longer afford to ignore quality. It is the author's opinion that America is now in much the same condition as this country was during the war with regard to the quality of her chocolate, except that the American public has never been educated to the standard of chocolate demanded in Europe. At the same time the industry is making great strides in America, and competition will no doubt soon bring about a change in the quality of the goods. Several "short-cut methods" of chocolate manufacture are described, but the author is of opinion that chocolate manufactured in the old-fashioned way, with careful consideration to every detail of the ingredients and processes of manufacture, is still unequalled for delicacy of flavour and aroma.

It is with a view to providing the manufacturer of high-class goods with full information regarding the raw material and processes of his trade that the book has been written, and in this the author has had the assistance of specialists in several of the branches dealt with. To anyone desiring

information regarding the subject of cocoa and chocolate manufacture this work may be recommended.

CANE SUGAR: A TEXTBOOK ON THE AGRICULTURE OF THE SUGAR-CANE, THE MANUFACTURE OF CANE SUGAR, AND THE ANALYSIS OF SUGAR-HOUSE PRODUCTS. By Noel Deerr. Second (revised and enlarged) Edition. Pp. viii + 644, 8vo, 10¾ × 6¾. (London: Norman Rodger, 1921.) Price 42*s*. net.

A notice of the first edition of this work appeared in this BULLETIN (1911, **9**, 89). Whilst preserving the original arrangement of the subject matter, the book has now been completely re-written and has benefited by the extensive experience which the author has lately gained in Cuba and in a New York sugar refinery. A number of new illustrations have been introduced, and an extensive bibliography and an historical conspectus of the sugar industry have been added to the appendix. The work will doubtless continue to maintain its position as a standard textbook on sugar-cane cultivation and the manufacture of cane sugar.

JUTE IN BENGAL. By Nibaran Chandra Chaudhury, of the Provincial Agricultural Service, Bihar and Orissa, formerly of the Bengal Service. Second Edition. Pp. xi + 288, 8vo, 7½ × 5. (Calcutta: W. Newman & Co., Ltd., 1921.) Price Rs. 5.

The author of this treatise has had a wide experience of the subject on which he writes, as he has been closely connected with the Indian jute crop for twenty-five years and was for some time in charge of the experiments in jute cultivation carried out at the Government Farm at Burdwan. The book first appeared in 1908, and has now been thoroughly revised and certain new chapters have been added. It deals with all aspects of the Indian jute industry, gives descriptions of the various races of the plant, the climatic and soil conditions best suited to its growth, its insect and fungoid enemies, and furnishes particulars of the areas devoted to the crop in the different Provinces. The methods of cultivating, cutting, retting, stripping, washing and baling are described, and figures are given to indicate the cost of production and the profit obtainable. Considerable space is devoted to an account of the experiments which have been carried out in Bengal on the isolation of the different races of the jute plant and to particulars of their distribution in the various districts

of growth, and also to trials made with a view to the discovery of methods of improving the fibre both in quality and yield. Details are given regarding the commercial classification of jutes and the various standard marks under which the fibre is exported, and reference is made to the history of the jute trade and the jute manufacturing industries of both India and Europe. A number of useful statistical tables are provided, and the principal jute substitutes are described, including the "malva" fibre of Cuba, Bimlipatam jute (*Hibiscus cannabinus*), and Sunn hemp (*Crotalaria juncea*). The book also contains several diagrams and illustrations, together with a map of the jute districts of India.

On the whole, the work has been carefully compiled, contains a great deal of useful information, and forms a valuable book of reference for all who are interested in jute, either from the agricultural or commercial standpoint.

PERFUMES, ESSENTIAL OILS, AND FRUIT ESSENCES. By Geoffrey Martin, D.Sc., Ph.D., F.I.C. Pp. ix + 138, 8vo, 10 × 6½. (London: Crosby Lockwood & Son, 1921.) Price 12*s.* 6*d.* net.

This little book is stated by the author to be written for practical men and manufacturers, and does not claim to be a comprehensive treatise. The first three chapters deal briefly with essential oils, their production, properties and uses, pages 13 and 14 containing all the author has to say regarding distillation, extraction, expression, maceration, and enfleurage methods of producing essential oils. Chapter IV, in two pages, mentions animal substances used in perfumery. A short account of the more important constituents of essential oils and synthetic compounds used in perfumery is given in the two succeeding chapters. The six chapters that follow consist principally of a large number of useful published recipes for handkerchief and soap perfumes, smelling salts, sachet powders, etc., and include a page on the blending of perfumes. The book concludes with a short chapter giving general methods of analysis of essential oils.

In the estimation of phenols by absorption in aqueous alkali, the author advises heating on the water bath for one hour, a procedure which is quite unnecessary and cannot be recommended. A number of misprints, and some misstatements occur; for example, *iso*-eugenol is stated to be easily converted into eugenol by alkalies.

TANNING MATERIALS, WITH NOTES ON TANNING EXTRACT MANUFACTURE. By A. Harvey. Pp. xvi + 182, 8vo, 8½ × 5½. (London: Crosby Lockwood & Son, 1921.) Price 15*s.* net.

The greater portion of this little book deals with the composition and properties of upwards of 200 different tanning materials. The author has collected his information from numerous sources, and has quoted from this BULLETIN the results of many analyses conducted at the Imperial Institute. The tanning materials are arranged alphabetically, according to their popular or native names, but a botanical index is also given.

The manufacture of tanning extracts is described, and a short account is given of the various methods of extracting, clarifying, and decolorising, together with a description of the different types of vacuum evaporators now employed in the production of liquid and solid extracts. One section of the book contains the official methods for the analysis of tanning materials prescribed by the International Association of Leather Trade Chemists and those of the American Leather Chemists' Association. The book also contains some miscellaneous information of interest to the manufacturer; for example, the utilisation of spent bark and wood waste. Here again reference is made to the work of the Imperial Institute on wood distillation and paper-making investigations.

The book contains thirty-six illustrative diagrams, chiefly of apparatus used in the manufacture of tanning extracts.

This little volume will form a useful addition to the present tanning literature, and will constitute a handy book of reference to tanners, manufacturers and others for information concerning the properties of all the tanning materials of any importance, and also of others of less importance or of doubtful value.

BROWN BAST: AN INVESTIGATION INTO ITS CAUSES AND METHODS OF TREATMENT. By A. R. Sanderson, F.L.S., and H. Sutcliffe, A.R.C.S., F.R.M.S. Pp. 71, 8vo, 9½ × 6½. (London: Rubber Growers' Association.) Price 7*s.* 6*d.* net.

The serious defect in *Hevea*, known as brown bast, seems to have been noticed in Java about 1912; but was at first confused with claret-coloured canker (*Phytophthora Faberi*). No fungus has been found to characterise affected tissue, nor have the symptoms proved traceable to any bacterium, so that most investigators, including

the authors of this brochure, have been driven to the conclusion that the disease is not a parasitic, but a physiological one. In attempting to combat the disease, hitherto, the symptoms rather than the cause of the disease have been attacked, and precautionary measures have been advocated that have been obviously based on a fear of infection, such as scraping away the diseased cortex, or a more drastic stripping, painting with hot tar in the former system, or spraying with paraffin wax in the latter. Resting the trees without any treatment has proved ineffective, the formation of brown bast being renewed after the interval of rest.

As the authors of this little book are both members of the Brown Bast Investigation Committee, set up at Kuala Lumpur in June 1918, it may be taken as representing what that committee has accomplished in the three years of its existence. The illustrations are excellent, though, perhaps, a still higher magnification might have proved more instructive; but the bibliography on page 66 is a somewhat inadequate representation of the work done by others. The whole book is too much of a laboratory notebook, with neither introduction nor conclusion to present the work done in its proper perspective for the benefit of the ordinary estate manager, to say nothing of the more general reader; and it is difficult to find anything in it that contributes to a clearer knowledge of the disease than is to be gathered from the dozen pages devoted to it in Mr. Petch's recent volume (see this BULLETIN, 1921, **19**, 257).

BREEDING CROP PLANTS. By Herbert Kendall Hayes, Professor of Plant Breeding, University of Minnesota, and Ralph John Garber, Head of Department of Agronomy, University of West Virginia. Pp. xvii + 328, 8vo, 9 × 6. (New York and London: McGraw-Hill Book Company, Inc., 1921.) Price 21*s*.

It is difficult for us in England to realise the public to whom this volume is intended to appeal. Our agricultural students are apt to complain of too much time being required for chemical courses which may enable them to analyse their own manures or feeding-stuffs, and they certainly would not care for such an advanced course of biological study as would qualify them to breed new varieties on strictly scientific lines. There is, we believe, still room for a small book explaining in simple non-technical language the principles on which the experts of the agricultural station proceed in raising new varieties; and the agricultural departments at home and in the colonies may

look for intelligent assistance from the farmer in the carrying out of large-scale tests of varieties that have already appeared to be remunerative when in plot-cultivation. The authors of this book, however, not only, as their official positions indicate, anticipate complete college courses in crop breeding, but also expect their students to have had a previous course in genetics; and they seem also to reckon on the carrying out of detailed field-plot experiments by the private grower. We doubt if, in any country, the working agriculturist can afford the time and labour which such work must involve in doing for himself what it should be the special function of the experts of the agricultural station to do for him. In the training of such experts, already a numerous body in the United States, the present volume might be useful. A somewhat sketchy history of the subject is followed by a brief outline of genetics which would undoubtedly prove too technical and abstruse for the uninitiated; but the third chapter reaching the more immediate subject of the book is a clearer and more practical discussion of modes of reproduction, though the section relating to hybrid vigour assumes a considerable amount of cytological knowledge. So, too, the following chapter, dealing with field-plot technique, bristles with mathematical formulæ. The practical instruction as to controlling pollination, and as to genetic classification into groups, varieties and strains, is clearly set out; and the fourteen remaining chapters, dealing in succession with what has been done in the breeding and selection of all the ordinary crop plants of temperate latitudes, will be most useful for reference to the grower. There is a brief glossary, and the bibliography of books and papers cited occupies twenty pages.

AN INTRODUCTION TO CYTOLOGY. By Lester W. Sharp. Pp. xiii + 452, 8vo, 9 × 6. (New York and London: McGraw-Hill Book Company, Inc., 1921.) Price 24*s*.

This is an excellent work, both well planned and well carried out. It is meant as an introduction to the literature and problems of cytology for students in biology, and especially botany. The history of the subject is treated adequately and in a perfectly readable style, and the cell, and the protoplasm and other cell-contents are then fully discussed, only a brief consideration being given to the cell-wall. The student is thus led gradually to the more difficult topic of nuclear division, and the questions of sex and heredity are not reached till the middle of the volume. Fourteen sectional bibliographies, occupying together about

80 pages, furnish abundant guidance to more detailed discussion. The nature of the subject prevents the book from being " easy reading " ; but it is seldom—and that only in the more theoretical part of the subject—that the author fails to elucidate even the most abstruse speculations. A considerable number of literal transpositions have escaped the proof-corrector, as when " mitosis " appears as " imitoss," which are annoying to the reader ; but otherwise the book is well printed, and is fully illustrated and indexed.

ELEMENTS OF ENGINEERING GEOLOGY. By H. Ries, Ph.D., and T. L. Watson, Ph.D. Pp. v + 365, 8vo, $8\frac{1}{2} \times 5\frac{1}{2}$. (New York : John Wiley & Sons, Inc. ; London : Chapman and Hall, Ltd., 1921.) Price 22*s.* net.

This handy little volume is practically a condensed form of the large textbook published by the authors in 1914–15, but a great deal has been rewritten and brought up to date. The aim has been to produce an elementary account of the phenomena of geology so far as they relate to engineering problems, and to cover fully such a wide ground in so small a book without sacrifice of clearness is a very difficult undertaking, upon the successful achievement of which the authors are to be congratulated.

As a textbook for elementary classes of engineering students the book may be confidently recommended. The numerous photographs, diagrams and maps are well chosen and clearly reproduced ; but such errors as the reversal of legends of Figs. 96 and 97 might well have been avoided.

PETROGRAPHIC METHODS AND CALCULATIONS, WITH SOME EXAMPLES OF RESULTS ACHIEVED. By Arthur Holmes, D.Sc.(Lond.). Pp. xx + 515, 8vo, $8\frac{1}{2} \times 5\frac{1}{2}$. (London : Thomas Murby & Co.) Price 31*s.* 6*d.* net.

This important addition to the literature of petrology deals with practical methods for the investigation of all classes of rocks. In contrast with other works on the same subject, too much stress has not been laid on optical methods, although these are adequately treated ; but all other methods for the identification and separation of minerals in the laboratory are fully described, and, in order to stimulate interest and research, the actual results obtained by various workers have been included.

Following an introductory chapter on the scope, aims and application of petrology and petrography, comes a very complete account of the methods for determining the specific gravity of minerals and rocks, including high

temperature determinations and a discussion on formula volumes of minerals and oxides. The next three chapters deal with methods for the separation and examination of crushed minerals and detrital sediments, with many practical examples and tables compiled to show comparisons of optical properties of minerals. These are followed by three chapters on the preparation and investigation of thin slices of rocks, one chapter being devoted to microchemical and staining tests, a very useful method of discriminating between certain minerals and one hitherto greatly neglected in textbooks. Here also are described the various areal and linear methods of estimating volume percentages, with numerous examples. The following chapter is devoted to an account of textures and structures of igneous and metamorphic rocks, and affords a useful glossary of the very large number of descriptive adjectives in current use. The two concluding chapters deal with the interpretation of results obtained by the chemical analysis of igneous rocks together with graphical methods of representation and equilibrium diagrams. In these, the American method for computing mineral composition by means of "normative" or hypothetical standard minerals is adopted and fully explained, and in conjunction with this part of the book the author has published, separately, copies of a general form for calculating the "norms" of igneous rocks quickly and neatly. The volume concludes with two appendixes containing useful numerical data and tables to assist in making calculations of "norms," four well-reproduced plates representing microphotographs of twenty-four rocks with descriptions, and an adequate index.

The book will prove useful to the student and experienced worker alike. It is full of the most up-to-date methods, and practical hints for manipulation; it abounds with examples of original work and references; it is illustrated with many tabular compilations of mineral properties, and the information is clearly set forth.

FIELD MAPPING FOR THE OIL GEOLOGIST. By C. A. Warner. Pp. x + 145, 8vo, 7 × 4½. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1921.) Price 13s. 6d. net.

This little book covers much the same ground as the recently published work, *Field Methods in Petroleum Geology*, by Messrs. Cox, Dake and Muilenburg (cf. this BULLETIN, 1921, **19**, 267), but it is rather more elementary than the latter work. The first chapter is a brief

study of field conditions. The second chapter deals with maps, their value and interpretation, including topographical, geological, structural, ownership, county and township maps, and concludes with a list of books recommended for a further study of the subject. The third chapter deals with methods of map making, contouring, reconnaissance mapping, subsurface maps and convergence sheets. The fourth chapter is on field-mapping instruments, their use and adjustment, and includes a description of the telescopic alidade and its use in obtaining distances and differences in elevation from stadia rod readings by simple levelling, stepping and vertical angles; but descriptions of the Beaman stadia arc, gradienter screw and other methods are not included. The "Brunton Patent Pocket Transit," which, besides forming an excellent clinometer, has been found very useful in reconnaissance work, is fully described, as well as levelling by the aneroid barometer and stadia hand-levelling. The fifth chapter gives methods for the determination of the meridian by equal altitudes of the sun and by Polaris, and of latitude by reckoning from a circumpolar star, a small transit theodolite being, of course, necessary for these observations. A number of useful tables and geological sections complete the work.

Oil Land Development and Valuation. By R. P. McLaughlin. Pp. viii + 196, 8vo, 7½ × 5. (New York: McGraw-Hill Book Company, Inc., 1921.) Price 18s. net.

This work is eminently practical. The first chapter deals with such important subjects as the location and spacing of wells, the investigation of productive formations, the rate of development and production, and the methods of well drilling, the advantages and disadvantages of rotary and cable tools being pointed out. The second chapter, which covers 50 pages, is devoted to the drilling of oil wells. A series of sketches shows how oil wells may be flooded by water, due to faulty casing, lack of cement, or through failure of development work to conform to geological conditions. The methods of measuring wells, the identification of strata, water, oil and gas encountered in drilling, the methods of excluding water by hydraulic cement and by other means, testing the condition of oil wells, testing casing for leaks, and the use of dyes and other substances for tracing the underground flow of water are the chief practical subjects dealt with in this chapter. The third chapter is on the assembling of information relative to underground conditions, such as maps, the graphic logs of wells, contour maps of underground surface, progress

charts and peg models. An interesting figure is reproduced from a photograph of a peg model of the Coyote Hills Oilfield, California, in which the two series of strings attached to the pegs (representing the wells) show the two oil-bearing strata and the dome-shaped structure of the field. The fourth chapter is on oil production, the methods of gauging the output of wells, and production records. The fifth chapter, comprising 73 pages, goes fully into the difficult subjects of repairing, deepening and abandoning wells. The modern method of exploding charges of blasting gelatin is described, as well as the use of fluid mud for closing a well on abandoning it, with details of the employment of the latter at Coalinga, California. Very instructive are the examples given of repair work in the Coalinga and Red River Fields, California, and the report on underground structure of the Montebello Oil Field, Los Angeles County, California, by Irving V. Augur. The sixth and last chapter, dealing with the value of oil land, the cost of production and market price of oil, is illustrated with graphs and diagrams.

THE TECHNICAL EXAMINATION OF CRUDE PETROLEUM, PETROLEUM PRODUCTS AND NATURAL GAS. By W. A. Hamor, M.A., and F. W. Padgett, M.S. Pp. ix + 591, 8vo, 9¼ × 6. (London and New York: McGraw-Hill Book Company, Inc., 1921.) Price 30s. net.

This work, written jointly by the Assistant Director of the Mellon Institute of Industrial Research and the Associate Professor in charge of the Petroleum Technology Department of the University of Oklahoma, fills a gap in the literature of the petroleum industry. As it has been written principally for American users, it is occasionally found that a European method of testing is mentioned but not described. Such omissions, however, are few, and more than balanced by the inclusion of a large number of standard methods of the American Society for Testing Materials.

The subjects dealt with in this volume include the sampling and examination of crude petroleum and its products, bituminous road-making materials and oil shales. Valuable chapters are given on the testing of products of the benzol recovery plant and the analysis of natural gas. There is also included an unusually large appendix (272 pages), which contains, in addition to a mass of data likely to be of service to chemists, petroleum technologists and engineers, numerous detailed specifications for petroleum products and road-making materials. The work, which concludes with a good index, will prove of great

service as a practical handbook to all engaged in the examination of petroleum products, whether in the United States or elsewhere.

COKE-OVEN AND BY-PRODUCTS WORKS CHEMISTRY. By Thos. Biddulph-Smith, F.C.S. Pp. x + 180, 8vo, 9 × 6. (London: Charles Griffin & Co., 1921.) Price 21*s.* net.

This is a useful compilation of the more important methods used and recommended for the analysis of coke-oven by-products. The title is somewhat misleading, as the book does not deal with the chemistry of the operations, but with the examination of the products obtained.

The examination of coal and coke is only briefly discussed, and the few lines given to the important question of methods of sampling these materials are inadequate. The chapter on "Calorimetry and Pyrometry" contains very brief descriptions of the apparatus used, and in most cases the instructions for their use are too scanty to be of service for working purposes. The methods for the analysis of the liquid and gaseous products of coke-ovens are dealt with in a more satisfactory manner, and in many cases where alternative processes are described useful comments on the relative accuracy are given.

The analysis of crude benzol is treated very thoroughly; the author quotes extensively the work of Coleman and Yeoman and of Spielmann and Wheeler, and includes a number of folding graphs which materially assist the calculation of results.

The first Appendix ("Some Constituents of Coal Tar and their Properties") is a translation by P. E. Spielmann of an article by Weger, which appeared in *Zeitschrift für angewandte Chemie*, and the second contains numerous data likely to be of service to those using the book. In spite of the shortcomings of the work, it should be of service to chemists engaged in the investigation of the products discussed.

TECHNICAL METHODS OF ANALYSIS, as employed in the laboratories of Arthur D. Little, Inc., Cambridge, Mass. Edited by Roger Castle Griffin, Director of Analytical Department. Pp. xv + 666, 8vo, 8 × 5½. (New York and London: McGraw-Hill Book Company, Inc., 1921.) Price 33*s*.

This book describes a large number of analytical methods recommended as being generally suitable for use in the ordinary procedure of a commercial laboratory. In

the earlier chapters an account is given of the preparation of reagents; the examination of various inorganic materials, including several chemicals, Bordeaux mixture, Paris green, and asbestos magnesia pipe covering; and methods of general organic analysis, such as the estimation of nitrogen, glycerol, tannic acid and nicotine, and the examination of alcohols, formaldehyde and formic acid solutions, dextrin, albumin and indigo. Other chapters deal with the analysis of metals, fuels, paint and paint materials, oils, fats, waxes and soaps, wood, paper and paper-making chemicals, textiles and textile fibres, foodstuffs, and a variety of miscellaneous products, including leather, tanning extracts, water, sewage, fertilisers, coal-tar, and Portland cement. The work concludes with an appendix, containing tables of atomic and molecular weights, analytical factors and a bibliography, and a good index is provided.

The methods are clearly described in accordance with the statement in the preface that "endeavour has been made to give such directions in each procedure that anyone reasonably familiar with analytical technique can readily follow them." Careful instructions are given for the preparation of samples for analysis, and a number of useful illustrations and diagrams are supplied.

The book will form a useful guide to analytical chemists generally, and particularly to those engaged in technical laboratories.

A TEXTBOOK OF ASSAYING. By C. and J. J. Beringer. Revised by H. R. Beringer. Fifteenth Edition. Pp. xvi + 471, 8vo, 8 × 5½. (London: Charles Griffin & Co., Ltd., 1921.) Price 12s. 6*d*. net.

The fifteenth edition of this standard textbook calls for little comment, as the general scheme is the same as in the preceding edition. In the present volume methods for the determination of tin, copper, arsenic, manganese, zinc, tungsten, and gold in cyanide solution have been added. Methods for the determination of the common metals by wet and dry methods are concisely and well described, but it would be interesting to know the authors' reason for the omission of the well-known "glyoxime" method for the estimation of nickel. Chapters on volumetric analysis, measuring and weighing, and specific gravity should prove useful to an assayer not very familiar with ordinary chemical manipulation. It is to be regretted that the standard of excellence in the description of methods for the determination of the common metals has

not been maintained in the sections dealing with the less common elements, such as tantalum, thorium, cerium, etc. The directions here given are so scanty as to be quite useless for accurate work. In this connection it might be suggested that in future editions the authors should, in such cases, insert references to the original literature on methods described. Throughout the present volume such references are exceptions rather than the rule.

The last four chapters of the book deal with the determination of the halogens, sulphur, arsenic, phosphorus, nitrogen, silicon, carbon and boron. In the description of the method for the determination of the calorific power of coal, there is no reference to modern types of calorimeters. The appendixes contain a list of atomic weights, tables of specific gravity of the common acids, further methods for the estimation of small quantities of gold, notes on the copper iodide process, a method for the separation of nickel and cobalt, the theory of sampling, wet assay of tin ores, and the Eastern Smelting Co.'s standard method for tin.

The book is primarily intended for the use of those connected with mines, and will undoubtedly prove of service to this class of reader, and also to chemists who have to deal with the determination of the commoner metals in ores.

HANDBOOK OF METALLURGY. By Dr. Carl Schnabel. Translated by H. Louis. Third Edition, Vol. I. Pp. xxi + 1171, 8vo, 9 × 6. (London: Macmillan & Co., Ltd., 1921.) Price 40*s*. net.

Previous English editions of this well-known textbook were prepared from the corresponding German editions, but in the case of the present volume the translator has revised the second edition independently, whilst retaining the original form of the book.

The work deals in great detail with the metallurgy of copper, lead, silver and gold, but although the volume is dated 1921, it is stated in the Preface that " much of this work had been completed and a good deal was in type by 1914, but the war delayed its publication." Those readers, therefore, who desire a work on this subject which is up to date in all respects will be disappointed in the present volume. In some cases the absence of recent information is apt to be misleading; thus, on p. 566 (Lead) the statement that " electrical methods of fume precipitation have also been tried, but have not yet passed into current practice " ignores the present-day employment of the Cottrell process. Similarly, the hydrometallurgy of

copper, and the use of basic lined converters in copper smelting are somewhat scantily treated, whilst the use of powdered coal as a fuel receives only a few lines.

Apart from the above-mentioned type of defects due to delay in publication, the volume deals with the metallurgy of copper, lead, silver and gold in a very thorough manner, the text being illustrated by a large number of diagrams, and the book should therefore prove of service to all interested in the metallurgy of these metals.

ELECTROLYTIC DEPOSITION AND HYDRO-METALLURGY OF ZINC. By Oliver C. Ralston. Pp. vii + 201, 8vo, 9 × 6. (London and New York: McGraw-Hill Book Company, Inc., 1921.) Price $3.

This is probably the first book that has appeared on this industry; for the electrolytic recovery of zinc successfully on a commercial scale is little more than seven years old. Its appearance is interesting in view of opinions recently expressed that the furnace methods of recovering zinc are doomed.

The introduction is followed by an interesting résumé of the history of the hydro-metallurgy of zinc since 1880. The roasting of zinc ores, the leaching, and the purification of the solution obtained are considered in Chapters III and IV, considerable attention being given to the methods for treating solutions containing deleterious impurities. It would appear that the most objectionable of the latter are cobalt and antimony. The former causes re-solution of the cathodes, and if it is present in the solution in greater proportion than 1 in 4,000 special means have to be taken to ensure its removal.

Succeeding chapters deal with the chloridising of zinc ores, electrolysis of solutions containing zinc sulphate and chloride, and electrolytic zinc refining, together with some good examples of the practice employed in certain works. The last chapter comprises a useful résumé of the economics of zinc hydro-metallurgy. The book considers the various operations from both the scientific and practical standpoint, and will no doubt form a welcome addition to the library of those interested in the metallurgy of zinc.

BOOKS RECEIVED

FIJI: ITS PROBLEMS AND RESOURCES. By Major W. A. Chapple, M.D., Ch.B., M.R.C.S., etc. Pp. 189, 8vo, 7 × 4¾. (Auckland, Melbourne and London: Whitcombe & Tombs, Ltd., 1921.)

TWENTY-FIVE YEARS IN EAST AFRICA. By John Roscoe, M.A. Pp. xvi + 288, 8vo, 8¾ × 5¾. (Cambridge: University Press, 1921.) Price 25*s*.

THE STUDY OF THE BRITISH COMMONWEALTH. An Inaugural Lecture delivered before the University of Oxford on November 19, 1921, by R. Coupland, M.A. Pp. 31, 8vo, 9 × 5¾. (Oxford: The Clarendon Press, 1921.) Price 2*s*.

AGRICULTURAL PROGRESS IN WESTERN INDIA. By G. Keatinge, C.I.E. Pp. xi + 253, 8vo, 4¾ × 7¼. (London: Longmans, Green & Co., 1921.) Price 6*s*.

A HANDBOOK OF THE FOREST PRODUCTS OF BURMA. By Alex. Rodger, O.B.E., F.L.S., I.F.S. Pp. ix + 128, 8vo, 8¼ × 5¼. (Rangoon: Superintendent, Government Printing, 1921.) Price Re. 1.

THE FLORA OF THE NILGIRI AND PULNEY HILL-TOPS. By P. F. Fyson, B.A., F.L.S. Vol. III. Pp. xviii + 581, 8vo, 8¾ × 5½. With 295 full-page illustrations by Mrs. Fyson and others. (Madras: Superintendent, Government Press, 1920.) Price 15 rupees, 6 annas.

NUT GROWING. By R. T. Morris. Pp. x + 236, 8vo, 7¾ × 5¼. (New York: The Macmillan Co.; London: Macmillan & Co., Ltd., 1921.) Price 13*s*.

A TEXTBOOK OF WOOD. By Herbert Stone. Pp. vii + 240, 8vo, 8½ × 5½. (London: William Rider & Son, Ltd., 1921.) Price 21*s*.

NOUVEAUX PARFUMS SYNTHÉTIQUES. By R. M. and J. Gattefossé. Pp. 208, 8vo, 9¼ × 5¾. (Lyons: Publications Pierre Argence, 1921.)

ANIMAL PROTEINS. By Hugh Garner Bennett, M.Sc. (Leeds). Pp. xiv + 287, 8vo, 8¾ × 5½. (London: Baillière, Tindall & Cox, 1921.) Price 15*s*.

Practical Leather Manufacture: A Handbook of Modern Processes of Leather Tanning, Dressing, Dyeing, Staining and Finishing, etc. Edited and arranged by Herbert G. Crockett. Pp. ix + 428, 8¾ × 5½. (London: The Leather Trades Publishing Co., Ltd., 1921.) Price 21s.

Synthetic Tannins: Their Synthesis, Industrial Production and Application. By Georg Grasser, Dr. Phil. Ing. Translated by F. G. A. Enna. Pp. viii + 141, 8vo, 8¾ × 5½. (London: Crosby Lockwood & Son, 1921.) Price 12s.

Standards and Tests for Reagent Chemicals. By Benjamin L. Murray. Pp. x + 385, 8vo, 9¼ × 6. (New York: D. van Nostrand Company; London: Constable & Co., Ltd., 1920.) Price 18s.

A Manual of Determinative Mineralogy. By Charles H. Warren, Ph.D. Pp. ix + 163, 8vo, 7½ × 5. (New York and London: McGraw-Hill Book Company, Inc., 1921.) Price 12s.

The Metallurgy of the Common Metals. By Leonard S. Austin. Fifth Edition. Pp. xvii + 615, 8vo, 9½ × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1921.) Price 42s.

Concentration by Flotation. Compiled and edited by T. A. Rickard. Pp. xi + 692, 8vo, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1921.) Price 42s.

Producer Gas. By J. Emerson Dowson, M.Inst. C.E., M.Inst.M.E., and A. T. Larter, M.B.E., B.Sc.(Lond.). Pp. xviii + 361, 8vo, 8¾ × 5¾. (London: Longmans, Green & Co., 1920.) Price 21s.

Oil-field Practice. By Dorsey Hager. Pp. ix + 310, 8vo, 7½ × 5. (New York and London: McGraw-Hill Book Company, Inc., 1921.) Price 18s.

Applied Entomology: An Introductory Textbook of Insects in their Relations to Man. By H. T. Fernald, Ph.D. Pp. xiv + 386, 8vo, 9 × 6. (New York and London: McGraw-Hill Book Company, Inc., 1921.) Price 21s.

HANDBOOK OF METEOROLOGY: A MANUAL FOR CO-OPERATIVE OBSERVERS AND STUDENTS. By Jacques W. Redway. Pp. v + 294, 8vo, 8¾ × 5½. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1921.) Price 24s.

THE ADVANCEMENT OF SCIENCE: 1921. Addresses delivered at the 89th Annual Meeting of the British Association for the Advancement of Science, Edinburgh, September 1921. 8vo, 8¾ × 5½. (London: John Murray, 1921.) Price 6s.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Dominion, Colonial and Indian Governments.

COTTON GROWING IN MOZAMBIQUE

In this Bulletin (1919, **17**, 421) an account was given of the possibilities of cotton growing in the valley of the Zambesi, Mozambique, based on a report made by Mr. John Percival of the British Cotton Growing Association. Eleven samples of cotton grown in the Mozambique Company's territory were received at the Imperial Institute in August 1921, and the results of their investigation are given in the present article. Before proceeding to a description of the cottons, the following particulars relating to the history of the cotton industry in Mozambique may be of interest. The information is taken from a report kindly prepared for the Imperial Institute by The Mozambique Industrial and Commercial Company, Ltd., a company formed in 1918 with a working arrangement with the Mozambique Company to purchase the native-grown cotton produced in the latter's territory.

Cotton was grown experimentally in Mozambique during 1900–1905 on the Buzi River, close to the port of Beira, and further experiments were carried out at Cherinda, one of the Mozambique Company's estates south of Beira on the coast. The results obtained in these localities, however, were not very satisfactory. At the suggestion of Senhor Costa, Commandant of the District of Chemba, experiments were subsequently undertaken in that district on land along the banks of the Zambesi, the cotton being grown by the natives, under his supervision. The Zambesi in the

Chemba District, which is about 150 miles from Chinde at the mouth of the river, overflows its banks every year and deposits silt in the alluvial flats or "dambos" (cf. this BULLETIN, 1919, **17**, 421), and it was on these flats that cotton growing first commenced. The seed originally imported was "Allen's American Long-staple No. 2" and "Griffin's." The former gave the best results, and it was proved that cotton of good quality could be grown in the district.

Senhor Costa, having demonstrated that cotton could be grown, commenced an active propaganda amongst the natives of his district in 1911, and the Mozambique Company installed a ginnery at Villa Fontes, about thirty miles lower down the river, to which the cotton from Chemba was transported in barges for ginning. The natives took readily to the cultivation of the crop, and a native cotton-growing industry was thus established. In 1914 the production was approximately 250 tons of seed-cotton, and this increased until in 1917 it was estimated that the growing crop in the district of Chemba would yield 2,500 tons of seed-cotton.

In 1916 the Mozambique Company decided to install an up-to-date ginnery at Chemba and treat all the cotton produced in that district on the spot. Unfortunately, in March 1917 a native rebellion broke out and the crop of growing cotton was destroyed. In 1919, normal conditions having again been established, 600 tons of seed-cotton were produced; in 1920 the output increased to 1,100 tons, and the same amount was produced in 1921.

The cultivation of cotton has now been extended to the interior districts, away from the river margin, and excellent cotton is being produced throughout the district of Chemba.

The Mozambique Industrial and Commercial Company supplies selected seed to all native cotton-growers free of charge. This seed is distributed by the Commandant of the district at the various cotton-growing centres, and its cultivation is carried on under the supervision of the Commandant and a staff of native supervisors. The cotton as picked is graded into two classes, No. 1 and No. 2, which are stored separately in receptacles held by the

natives at their villages. When the whole crop has been gathered, various buying centres are established, and the cotton is purchased by the Commandant at approximately 1½*d.* per lb. for seed-cotton of first grade and 1*d.* per lb. for the second grade. The cotton is then transported to the ginnery, where it is treated and shipped down the Zambesi for transport overseas.

Varieties of seed derived from Nyasaland cotton have principally been experimented with, but on the whole these have not given very satisfactory results in Chemba. A type of seed, however, has now been standardised as a result of careful selection from American and Nyasaland cottons, and it is from this seed that the cotton is at present being produced. The quality of the cotton compares favourably with other African cottons and usually realises a price in Europe from 1½*d.* to 2*d.* per lb. in advance of "middling" American.

Large tracts of land suitable for cotton growing have been reserved by the Mozambique Company in the district of Chemba, and it is estimated that if all the land available were put under cultivation, an annual output of 5,000–6,000 tons of seed-cotton could be obtained. Owing, however, to the heavy calls on the district for native labour required for the various other industries of the territory, this estimate has not yet been realised.

The cottons received at the Imperial Institute consisted of three samples of lint, two saw-ginned and one knife-ginned, and eight samples of seed-cotton. The latter represented grades 1 and 2 of two different varieties. The results of their examination are given in the following pages; the cottons were valued commercially in Liverpool in September 1921, when "middling" American futures were quoted at 14·50*d.* per lb.

Lint

No. 1. "*Saw-ginned, A.* 1920–21."—This was cream-coloured, lustrous cotton, fairly clean and free from stains, but a little "leafy" and containing some immature fibre. It was soft and rather weak, and ranged in length from 0·7 to 1·2 in., being mostly from 0·8 to 1·1 in., with an average of 0·95 in.

The cotton was valued nominally at 14·50*d*. per lb. It was, on the whole, of good quality, but was rather soft.

No. 2. "*Saw-ginned, B.* 1920–21."—This cotton was lustrous, pale cream-coloured, and contained some "leaf," undeveloped seeds and immature fibre. It was of fairly good strength, but the fibre was soft and weak in parts. The length of the fibres ranged from 0·7 to 1·1 in., being mostly from 0·8 to 1·0 in.

The cotton was valued nominally at 13·00*d*. per lb. It resembled No. 1, but was of irregular strength.

No. 3. "*Knife-ginned, A.* 1920–21."—This was lustrous, soft, cream-coloured cotton, fairly clean, but containing some immature fibre and showing occasional yellowish-brown stains. It was of good strength on the whole, but was weak in parts. The length of the fibres ranged from 0·8 to 1·2 in., being mostly from 0·9 to 1·1 in.

The cotton was valued nominally at 15·50*d*. per lb., being more valuable than Nos. 1 and 2 owing to its rather longer staple.

Seed-cotton

No. 4. "*Zeche No.* 1."—This gave 29·2 per cent. of lint on ginning; the yield per 100 seeds was 4·8 grams. The lint was soft, lustrous, white and clean, but contained some immature fibre. The seeds were in some cases brown and in others bright green, and were covered with fuzz.

The cotton was of good strength, and the length of the fibres ranged from 0·7 to 1·4 in., being mostly from 1·0 to 1·2 in.

No. 5. "*Zeche No.* 1."—The yield of lint on ginning in this case was 29·0 per cent.; the yield per 100 seeds was 4·1 grams. The lint and seeds were of similar character to those of No. 4.

This cotton was also of good strength. The fibres ranged in length from 0·9 to 1·5 in., being mostly from 1·1 to 1·3 in.

No. 6. "*Zeche No.* 1."—This gave a yield of 29·6 per cent. of lint on ginning; the yield per 100 seeds was 5·4 grams. The lint and seeds of this sample also were very similar to those of No. 4.

The strength of the cotton was good, and the length

varied from 0·6 to 1·5 in., being mostly from 1·0 to 1·3 in., with an average of 1·1 in.

The first sample of " Zeche No. 1 " (No. 4) was valued nominally at 19·00*d.* per lb. The other two samples were practically identical with the first and would have a similar market value. The higher value of this cotton, as compared with Nos. 1–3, was due to the more satisfactory length and good strength.

No. 7. " *Zeche No.* 2."—The yield of lint on ginning was 31·0 per cent.; the yield per 100 seeds was 3·5 grams. The lint was white, stained with occasional yellow patches, and contained some immature fibre. The sample was somewhat "leafy" and of poor lustre, and showed evidence of the attack of insect pests. The seeds, some of which were brown and some green, were in nearly all cases covered with fuzz.

The cotton was of fair but irregular strength. The length of the fibres ranged from 0·8 to 1·3 in., being mostly from 1·0 to 1·1 in.

This cotton was inferior to the samples of " Zeche No. 1" both in strength and colour, and was valued nominally at 15·50*d.* per lb.

No. 8. " *Chave No.* 1."—This gave a yield of 32 per cent. of lint on ginning; the yield per 100 seeds was 4·3 grams. The lint was soft, lustrous and white, free from stains, but containing some immature fibre. The seeds were brown and mostly bore white to brown fuzz, a few having green fuzz.

The strength was good, and the length ranged from 0·8 to 1·3 in., being mostly from 0·9 to 1·2 in., with an average of 1·1 in.

No. 9. " *Chave No.* 1."—This cotton yielded 32 per cent. of lint on ginning; the yield per 100 seeds was 4·8 grams. The lint and seeds were similar to those of No. 8.

The cotton was of good strength, and its length ranged from 0·9 to 1·4 in., being mostly from 1·0 to 1·3 in., with an average of 1·1 in.

No. 10. " *Chave No.* 1."—The yield of lint on ginning in this case was 32 per cent., and the yield per 100 seeds was 4·3 grams. The lint and seeds were again similar to those of No. 8.

The cotton was of good strength, and the length of the fibres varied from 0·7 to 1·2 in., being mostly from 0·8 to 1·1 in., with an average of 1·0 in.

The first sample of "Chave No. 1" (No. 8) was valued nominally at 16·50*d.* per lb. The other two samples were very similar and would have about the same value. This "Chave No. 1" cotton was of good strength and colour, but was slightly inferior to "Zeche No. 1" (Nos. 4–6), the latter being, on the whole, of better appearance.

No. 11. "*Chave No.* 2."—This gave a yield of 29 per cent. of lint on ginning; the yield per 100 seeds was 4·0 grams. The lint was soft, lustrous and white, showing yellowish-brown stains, and containing some immature fibre. The seeds were brown, and in most cases bore white to brown fuzz, a few bearing green fuzz. The sample showed signs of insect attack.

The strength was good, and the length ranged from 0·9 to 1·3 in., being mostly from 0·9 to 1·2 in., with an average of 1·0 in.

The cotton was valued nominally at 16·00*d.* per lb. It was slightly inferior to "Chave No. 1" (Nos. 8–10) owing to the presence of stains.

NEW AFRICAN FEEDING STUFFS

In the following pages are given the results of examination of three kinds of seeds from Africa, which have been forwarded recently to the Imperial Institute in order that their value as feeding stuffs might be ascertained.

SESBANIA CINERASCENS SEED FROM SOUTH AFRICA

The seed of a Sesbania from the Transvaal was examined at the Imperial Institute in 1919 (this BULLETIN, 1919, 17, 184). The particular species from which this seed was derived was not stated at the time, but the Chief, Division of Botany, has recently informed the Imperial Institute that it was *S. mossambicensis*, Klotz. In August 1921 seeds of another species, *S. cinerascens*, obtained from Louwe Creek, near Barberton, Transvaal, were received for examination. The latter seeds differed both in appearance

and in size from those previously examined. They were narrow and oblong, about $\frac{5}{16}$ in. long and $\frac{1}{8}$ in. thick. The colour of the seed-coat varied from dark greyish to yellowish-green. Many poorly developed and shrivelled seeds were present, together with a small amount of stalk.

The seeds were analysed with the following results, which are shown in comparison with the corresponding figures recorded for the sample of *Sesbania mossambicensis* seed from the Transvaal and for the "gram" (*Phaseolus Mungo*) of commerce :

	Sesbania cinerascens seed.	*Sesbania mossambicensis* seed.	"Gram" (*Phaseolus Mungo*).
	Per cent.	*Per cent.*	*Per cent.*
Moisture	11·4	9·6	10·1
Crude proteins	21·7	32·9	22·7
Fat	4·8	6·2	2·2
Starch, etc. (by difference)	47·0	39·0	55·8
Fibre	12·2	10·9	4·8
Ash	2·9	1·4	4·4
Nutrient ratio [1]	1 : 2·7	1 : 1·6	1 : 2·7
Food units [2]	113	137	118

[1] *The ratio between the percentage of crude proteins and the sum of the percentages of starch and fat, the latter being first converted into its starch equivalent.*

[2] *The total obtained by adding the percentage of starch to 2·5 times the sum of the percentages of fat and crude proteins.*

The seeds did not contain any cyanogenetic glucoside, but a trace of a substance giving the usual tests for alkaloids was present.

The above results show that the *Sesbania cinerascens* seed closely resembles "gram" in composition, but contains slightly less protein and considerably more fibre. The composition of the seeds is also similar in several respects to that of the *Sesbania mossambicensis* seeds examined at the Imperial Institute, but they contain considerably less protein and would therefore have a lower feeding value.

These *Sesbania cinerascens* seeds are of satisfactory composition as a feeding stuff for animals, but in view of the possible presence in them of a trace of alkaloid, trials would be necessary to determine whether they are harmless. If this should prove to be the case, the seeds would probably be saleable in the United Kingdom for use in the manufacture of feeding stuffs, in competition with gram.

At present they would be worth nominally about £6 per ton in London (December 1921).

SUNN HEMP SEED FROM RHODESIA

Seed of *Crotalaria juncea*, the plant which yields the fibre known as sunn hemp, was received from Rhodesia in January 1920. It was stated by the Director of Agriculture, in forwarding the seeds, that the plant grows freely in Rhodesia, and promises to be of great value in rotation. It may, perhaps, not be possible to recommend it to be grown as a fibre crop, but if the plant and seed could be used with safety as fodders, this would do much to popularise it in the country.

The seeds were small and flat, about ⅛ in. long, mostly varying in colour from greenish to dark bluish-grey. They were analysed with the following results:

	Per cent.
Moisture	8·6
Crude proteins	34·6
Consisting of:	
True proteins	31·2
Other nitrogenous substances	3·4
Fat	4·3
Starch, etc. (by difference)	41·1
Fibre	8·1
Ash	3·3
Nutrient ratio	1 : 1·5
Food units	138

The seeds did not contain any cyanogenetic glucosides, but a substance was present which gave reactions similar to those of alkaloids, and it might therefore be dangerous to use the seeds as a feeding stuff. The seeds of allied species of *Crotalaria*, e.g. *C. retusa*, *C. sagittalis* and *C. striata*, contain an alkaloid which is probably cytisine, a highly toxic substance.

Sunn hemp seeds contain a large percentage of proteins, but they do not appear to be generally used as a feeding stuff for cattle, although it has been stated that in some parts of India they are employed for this purpose.

In view of the possibility that the seeds contain a poisonous alkaloid, it was pointed out that careful trials would be necessary before they could be recommended for

feeding cattle. Acting on this suggestion, preliminary feeding trials have been conducted by the Department of Agriculture. The results seem to indicate that the seed is harmless to sheep when fed in small quantities, but that it is not suitable for use in large quantities. No ill effects were noticeable when ¼ lb. of the seed, mixed with maize, was fed to a sheep daily for a fortnight, but when double this quantity was given, the sheep began to show signs of partial paralysis and general indications of poisoning, and after 10 days it died. The sunn hemp seed was objectionable to the sheep, and therefore not eaten readily.

Feeding experiments with the sunn hemp plant as green fodder have also been conducted in Rhodesia. Two merino ewes were given quantities up to 2 lb. per head per day, but throughout the experiment great difficulty was experienced in getting them to eat it, and at no time did they eat more than ¾ lb. per head per day. The experiments were continued for about 16 weeks, and neither ewe at any time showed any ill effects from the diet, so that even if injurious the green fodder is apparently not acutely poisonous.

Schotia Seeds from Portuguese East Africa

The seeds which are the subject of this report were collected in Portuguese East Africa by Dr. Pole Evans, Chief, Division of Botany, Union of South Africa. They were identified at the Royal Botanic Gardens, Kew, as a species of *Schotia*, near *S. latifolia*. *Schotia* is a genus of tropical and South African plants belonging to the Leguminosæ. The seeds of *S. latifolia* and *S. speciosa* are stated to be roasted and eaten by the natives in parts of South Africa.

The seeds received were smooth and buff-coloured, with large pale yellow arils, many of which had become detached. The entire seeds consisted of 45 per cent. aril and 55 per cent. actual seed, and had an average weight of about 2 grams.

The seeds measured about 0·7 in. in length, 0·5 in. in width and about 0·25 in. in thickness. The seed-coat was extremely hard, and difficult to remove. Between this and the hard pale yellow interior was a dark red layer which had a resinous appearance.

The arils and seeds were submitted separately to chemical examination with the following results:

	Aril. Per cent.	Seed. Per cent.
Moisture on drying at 100° C.	9·4	9·6
Oil, extracted by light petroleum	0·4	2·4

In view of these small yields neither the arils nor the seeds would be of value as a commercial source of oil.

The arils when ground were sticky and apparently resinous, and, as already stated, the seeds contained a substance of resinous character. Experiments were, therefore, made in order to ascertain whether any resin was actually present either in the arils or in the seeds. On extraction with acetone, after the removal of the oil, the arils yielded 24·0 per cent. and the seeds 5·4 per cent. of extract. That obtained from the arils was a bright yellow solid substance, soluble in hot water, and was therefore not a true resin. The extract from the seeds appeared to consist largely of the dark material lying between the seed-coat and the pale yellow interior; it was sparingly soluble in acetone or alcohol, and partially soluble in water.

The seeds, after removal of the arils, were submitted to chemical examination as a possible feeding stuff, with the following results:

	Per cent.
Moisture	8·6
Crude proteins	9·8
Consisting of:	
True proteins	8·6
Other nitrogenous substances	1·2
Fat	2·6
Carbohydrates (by difference)	68·2
Fibre	8·7
Ash	2·1
Nutrient ratio	1 : 7·6
Food units	99

The seeds contained no alkaloids or cyanogenetic glucosides.

The above figures show that the seeds are rich in carbohydrates, but contain only a moderate percentage of proteins and a low percentage of fat. They have a fair nutritive value, but are unlikely to be saleable for human

food, as they assume a dark unattractive colour when boiled, and have but little flavour. They might be of some use as a cattle food, but the seed-coat and interior are hard, and in any case feeding trials would be necessary to determine their suitability for this purpose.

The arils have an unpleasant flavour, which would probably prevent their use as a cattle food, even if they did not prove objectionable in other respects.

It is evident from the foregoing report that these Schotia seeds would not be of much commercial value. They might perhaps be employed locally as a cattle food, but it is unlikely that their collection for export would be remunerative.

NAULI "GUM": A NEW OLEO-RESIN FROM THE SOLOMON ISLANDS

The "gum" which is the subject of this report was forwarded to the Imperial Institute by the Institute of Science and Industry, Melbourne, in May 1921. It was stated that the product is yielded by a large tree which is plentiful in the Solomon Islands, and that it should be possible to obtain considerable quantities if there were a market for it. It was therefore desired to ascertain the possible uses of the "gum" and its value in the United Kingdom.

The sample consisted of lumps of a fairly soft oleo-resin with a strong odour of aniseed. It was pale yellow with occasional black streaks, and somewhat sticky. A small amount of dirt was present.

The oleo-resin was chemically examined at the Imperial Institute with the following results:

	Per cent.
Moisture	2·5
Volatile oil	10·4
Resin	81·8
Matter soluble in water	3·7 [1]
Matter insoluble in alcohol (mineral and vegetable impurities)	1·6

[1] *This consisted largely of anisic acid. No gummy matter was present.*

The volatile oil, obtained by distilling the oleo-resin in a current of steam, was a pale yellow limpid liquid, with an odour of aniseed. It had the following constants:

Specific gravity at 15°/15° C.	0·9592
Optical rotation α_D 20°	−25·91°
Refractive Index n_D 20°	1·5348
Acid value	0·65
Ester value before acetylation	1·6
Ester value after acetylation	24·6

On distilling the oil under atmospheric pressure the following fractions were obtained:

Fraction boiling at	*Per cent.*
175°–190° C.	1·7
190°–205° C.	5·8
205°–220° C.	11·7
220°–227° C.	16·7
227°–236° C.	57·7[1]
Residue	6·4

[1] *The congealing point of this fraction was* 9·5° C.

When the original oil was cooled to a temperature of 4·5° C. it became semi-solid owing to the separation of a crystalline substance which was identified as anethole (the characteristic constituent of anise oil). The amount of anethole in the oil so far as could be determined with the small quantity available was approximately 34 per cent.

The resin remaining after the removal of the volatile oil was dissolved in alcohol and the solution filtered to free it from mineral and vegetable impurity, the alcohol being subsequently removed by distillation. The purified resin thus obtained was reddish-brown, transparent, hard and very brittle; it melted at about 69°–71° C., and had an acid value of 9·0 and an ester value of 16·4. The resin was insoluble in solutions of caustic alkali.

Varnish prepared with one part of the purified resin and two parts of methylated spirit, and applied to sized wood, dried rapidly to a pale, rather soft coat, which in a day or two became hard and lustrous, but was rather readily scratched.

A sample of the volatile oil prepared from the oleo-resin was forwarded to essential oil distillers, who reported that it could be used as a substitute for anise oil, although it possesses only about half the flavouring power of star

anise oil, and would therefore have a correspondingly lower value. On this basis it was considered that the oil would not realise more than 1*s.* per lb. in London with anise oil at 2*s.* 1*d.* per lb. (November 1921).

The resin remaining after the removal of the volatile oil was stated by varnish makers to have properties distinct from those of ordinary rosin, and to resemble gum dammar in certain respects. They considered that the resin should therefore be suitable for making varnishes for mixing with various colours which could not be mixed with ordinary rosin varnish. The material could also be used as a substitute for rosin in spirit varnish and also in oil varnish. The opinion was expressed that the resin would have a commercial value at least equal to that of ordinary rosin of the same colour, which in November 1921 was quoted in London at about 16*s.* per cwt.

General Conclusions

The results of the examination show that this Nauli "gum" consists of an oleo-resin which furnishes about 10 per cent. of volatile oil on steam distillation. This oil is quite unlike the turpentine oils of commerce, and the results so far obtained indicate that it contains only a relatively small quantity of terpenes and about 34 per cent. of anethole. The oil would therefore be of no value as a turpentine substitute, but it might be utilised as a substitute for anise oil or as a source of anethole.

The resin left after the removal of the volatile oil could be utilised for varnish making, but owing to its insolubility in caustic alkali it would be unsuitable for the production of resin soaps or resin size.

The most practical method of exploiting the crude Nauli "gum" would be to arrange for its distillation in the Solomon Islands or in Australia by means of a simple still, and to market the oil and resin separately. It was suggested to the authorities that if the prices quoted for the oil and resin in London appear likely to be remunerative, samples of both products (say 2 to 3 lb. of the oil and 28 lb. of the resin) should be prepared and forwarded to the Imperial Institute for technical trials so that their value could be definitely determined.

WATER-HYACINTH ASH AS A MANURE AND SOURCE OF POTASH

The water-hyacinth (*Eichornia crassipes*) is a troublesome weed in many parts of the tropics, sometimes occurring in such abundance as to block up ditches and irrigation channels. Its removal, therefore, is often a matter of necessity, and it has been suggested that the plants might be burnt and the ashes employed as a source of potash or as a manure. Particular attention has been paid in India to the possibility of using the ash as a manure for jute (cf. this BULLETIN, 1917, **15**, 283).

In June 1921 water-hyacinth ash prepared in Burma was forwarded to the Imperial Institute in order to ascertain whether the material could be usefully employed as a fertiliser or for any other purpose. The sample consisted of dark brown ash, containing a large proportion of extraneous mineral matter (apparently sand or soil) and a quantity of charred material.

About 11 per cent. of the crude ash was soluble in water, the solution having an alkaline reaction. The portion soluble in water had the following composition:

		Per cent. of original ash.
Potash	K_2O	4·76
Soda	Na_2O	1·22
Lime	CaO	0·26
Magnesia	MgO	0·23
Chlorine	Cl	3·91
Sulphuric anhydride	SO_3	0·88
		11·26

Carbonates were absent.

A partial analysis of the portion insoluble in water gave the following results:

		Per cent. of original ash.
Potash	K_2O	1·51
Soda	Na_2O	0·66
Lime	CaO	4·49
Magnesia	MgO	2·29
Phosphoric anhydride	P_2O_5	4·17
Residue (silica, etc.)		50·36

The chief constituents of value in (*a*) the water-soluble portion and (*b*) the insoluble portion of the ash were as

follows, the proportions being calculated on the ash as received :

		Soluble portion of ash. Per cent. of original ash.	Insoluble portion of ash. Per cent. of original ash.
Potash	K_2O	—	1·51
Potassium chloride	KCl	7·54	—
Sodium chloride	NaCl	0·51	—
Sodium sulphate	Na_2SO_4	1·56	—
Magnesium carbonate	$MgCO_3$	—	4·16
Calcium phosphate	$Ca_3(PO_4)_2$	—	8·20

The percentage of potash in the ash is much below that found in similar material prepared in Bengal, as recorded in "Water Hyacinth: Its Value as a Fertiliser" (*Bulletin* No. 71, 1917, *Agricultural Research Institute, Pusa*). It is shown, however, in this publication that the quantity of potash present in the ash varies considerably. The ash obtained from the largest plants is usually the richest in potash, whilst that from stunted plants, growing in certain districts of India either on land or in shallow water, contains less potash and much silica. A higher yield of ash is, however, generally obtained from the latter type of plant.

The following are some previously recorded analyses of the ash of the water hyacinth :

		Narayanganj.	Dacca.	Mirpur.	Federated Malay States (mean of 10 analyses).
Potash	K_2O	28·7	34·1	11·3	15·3
Lime	CaO	12·8	8·4	7·8	—
Chlorine	Cl	21·0	20·4	5·7	—
Silica	SiO_2	—	20·7	49·4	—
Phosphoric anhydride	P_2O_5	7·0	8·2	1·4	2·8

The percentage of potash in the present sample, although low, is as high as that found in one sample prepared in the Federated Malay States, which was obtained from plants described as "small and leafy, somewhat broken up, growing in swamp" (*Agricultural Bulletin, Federated Malay States*, 1918, **6**, 313).

It is evident from the investigations carried out in India and the Federated Malay States that the amount of potash in water-hyacinth ash varies largely with the

conditions under which the plant grows, and it is therefore possible that the low percentage of potash in the present material is due to this factor. Another explanation of the low percentage of potash may be that the plants after collection, or the ash after its preparation, were exposed to rain, and that in consequence some of the potash was washed out.

As already stated, the ash as received contained a large percentage of insoluble matter, partly in the form of sand or soil. If it were possible to free the plants more thoroughly from soil before burning them, the percentage of potash in the ash would be increased.

Water-hyacinth ash similar to the present sample would be suitable for local use as a potash manure. The presence of a little phosphoric acid adds slightly to its manurial value.

The ash differs materially from that obtainable from most varieties of wood, in that its chief constituent soluble in water is potassium chloride, whereas in wood ash the potash is present largely as potassium carbonate. It is therefore evident that the ash of water hyacinth could not be used like wood ashes for the preparation of crude "potashes." As about 75 per cent. of the water-soluble matter in the ash consists of potassium chloride, the other constituents being chiefly sodium sulphate and sodium chloride, the preparation of potassium chloride of fairly good quality from the ash by extraction with water and subsequent crystallisation should be easy. It would, however, be necessary to extract about 14 tons of ash similar in composition to the present sample in order to obtain a ton of 80 per cent. potassium chloride, which would only be worth about £11 in the United Kingdom at the present time. On this basis it seems very unlikely that it would be remunerative to use the ash as a source of potassium chloride.

It was pointed out that it would be desirable to prepare further samples of the ash from plants growing under different conditions in Burma in order to determine the variations in the amount of potash, and it was recommended that in any further trials care should be taken to free the plants from soil so far as possible before they are burnt.

PENGUIN GUANO FROM THE FALKLAND ISLANDS

In this BULLETIN (1914, 12, 208) a report was published on the results of examination of penguin guano from Cochon and Kidney Islands, of the Falkland Islands group. It was found that the guano was poorer in manurial constituents than good Peruvian guano, and it was suggested that material situated below the surface of the deposit might possibly be richer than the samples examined. Further samples from Kidney Island were received from the Government Geologist in November 1921, together with some of the liquid which percolates through the guano deposit. The results of the examination of these materials are given in the following pages. It may be mentioned that large quantities of so-called guano are exported from the Falkland Islands; this, however, is not a naturally occurring material like the penguin guano and Peruvian guano, but is prepared from the carcases of whales.

The samples received were labelled as follows:

No. 1. "From sampling site A, 3–4 ft. down in the deposit."

No. 2. "From sampling site B, 2–3 ft. down in the deposit."

No. 3. "From sampling site C, 1st foot down in the deposit."

No. 4. "From sampling site D, 1st foot down in the deposit."

No. 5. "From sampling site E, 1–3 ft. down in the deposit."

These five products all consisted of dark brown guano in a very moist condition.

No. 6. "Liquid percolating through deposit at sampling site B, 2–3 ft. down."—This was a brown aqueous liquid.

The five guanos were examined with the following results:

	No. 1. *Per cent.*	No. 2. *Per cent.*	No. 3. *Per cent.*	No. 4. *Per cent.*	No. 5. *Per cent.*
Moisture on drying at 105° C.	78·25	49·38	80·09	77·87	56·66
Additional loss on ignition	19·56	7·25	16·16	20·43	41·64
Ash	2·19	43·37	3·75	1·70	1·70

Chemical analyses of the materials gave the following results, which are expressed in each case on the guano as received :

	No. 1. Per cent.	No. 2. Per cent.	No. 3. Per cent.	No. 4. Per cent.	No. 5. Per cent.
Lime	0·52	0·25	1·21	0·25	0·13
Magnesia	0·16	0·13	0·55	0·13	0·11
Phosphoric anhydride (P_2O_5)	0·16	0·09	1·74	0·18	0·09
Consisting of:					
Portion soluble in 2 per cent. citric acid solution[1]	0·16	0·07	1·60	0·18	0·071
Portion insoluble in 2 per cent. citric acid solution	nil	0·02	0·14	nil	0·019
Nitrogen (N)	0·808	0·488	0·62	1·03	0·434
Consisting of:					
Portion present in organic form	0·696	0·429	0·51	0·82	0·428
Portion present as ammonium salts . . .	0·104	0·055	0·04	0·19	nil
Portion present as nitrates	0·008	0·004	0·07	0·02	0·006

[1] *Including phosphoric anhydride (P_2O_5) soluble in water*	0·09	0·02	0·92	0·17	0·064

The liquid (No. 6) from sampling site B was found to consist of water containing 0·66 per cent. of total solids, which consisted largely of soluble phosphates.

These guanos are very similar in composition to the two previous samples from Kidney Island which were dealt with in the earlier report of the Imperial Institute. If the guanos were dried until only 20 per cent. of moisture remained, they would contain the amounts of manurial constituents shown in the following table, to which corresponding figures for typical Peruvian guanos are added for purposes of comparison :

	Phosphoric anhydride, P_2O_5. Per cent.	Nitrogen, N. Per cent.	Moisture. Per cent.
Falkland Islands.			
Present sample No. 1.	0·59	2·97	20
" " " 2.	0·14	1·09	20
" " " 3.	6·99	2·49	20
" " " 4.	0·65	3·73	20
" " " 5.	0·16	0·80	20
Peruvian guanos:			
Lobos de Afuera Is.	16·70	3·60	19·60
Guanape Is.	12·25	11·00	25·88
Ballestas Is.	12·23	12·50	14·87

From these figures it will be seen that the present samples from Kidney Island are very inferior to good

Peruvian guanos in respect of the amounts of nitrogen and phosphoric acid which they contain. The water (sample No. 6) percolating through the guano deposit at site B was found to contain soluble phosphates, and it seems likely that the inferior quality of the guano may be due to prolonged leaching by rain water.

The present materials, if shipped in the condition in which they were received at the Imperial Institute, would in no case be worth as much as £1 per ton delivered in the United Kingdom. If, however, facilities could be arranged for drying the guano in the Falkland Islands, it would be possible to prepare a partially dried material from guanos Nos. 1, 3, 4 and 5 which could be used as an organic filling material in the manufacture of compound manures, and would be of somewhat higher value. Guano No. 2 would not be suitable for use in this way, as it contains little organic matter.

AUSTRALIAN POTTERY CLAY

White clay from a deposit near Bendigo, in the State of Victoria, has been examined recently at the Imperial Institute with a view to ascertaining its suitability for the manufacture of porcelain and refractory bricks. The clay contained a quantity of gritty matter composed of quartz with a little felspar. It was first washed to remove the gritty matter, the presence of which would interfere with the successful working of the clay, and the grit thus removed amounted to about 4 per cent. by weight of the sample. The washed clay was analysed with the following results:

		Per cent.
Silica	SiO_2	65·25
Alumina	Al_2O_3	22·16
Ferric oxide	Fe_2O_3	0·87
Titanium dioxide	TiO_2	0·59
Lime	CaO	0·38
Magnesia	MgO	0·82
Soda	Na_2O	0·42
Potash	K_2O	1·68
Sulphuric anhydride	SO_3	0·30
Loss on ignition		7·58

These figures do not correspond with those of china

clay of first-class quality, the amount of alumina being too low whilst the percentages of silica and of metallic oxides other than alumina are too high.

Trials for the Production of Pottery and Porcelain

(1) On mixing the dry washed clay with water a very plastic mass was obtained, which worked well on the jigger and jolley machine. A vessel made in this way and dried in the air was sufficiently strong to bear handling. It was then fired to a temperature of 1050° C. for six hours and yielded a strong white " biscuit," suitable for covering with a transparent or opaque glaze.

The total shrinkage on firing was about 8 per cent., the water-absorption of the fired material 13·5 per cent., and the transverse breaking stress about 870 lb. per sq. in. The shrinkage is therefore not high, and the porosity is sufficient to permit of the application of a glaze by dipping, whilst the strength is considerable. The washed clay is therefore suitable for the manufacture of fine white glazed earthenware.

(2) As already indicated, the sample had the properties of a plastic clay rather than of a kaolin. Plastic clay is generally unsuitable for the production of porcelain, as it yields a " body " which is too fusible or too opaque and not of the required whiteness. Occasionally, however, it has been found possible to utilise plastic clay for this purpose, and trials were therefore made at the Imperial Institute in order to determine whether the present material could be so used.

Vessels were prepared from mixtures of the washed clay with varying quantities of " Cornish stone " (a felspathic rock) and ground flint (silica), and fired to a temperature of about 1350° C. The porcelain produced was, however, in all cases too fusible and not of good white colour. The prospects of using the clay for the manufacture of hard porcelain are therefore not promising.

The " porcelain " produced from the clay in conjunction with " Cornish stone " and silica may, however, be regarded as a form of fine stoneware, which could, if necessary, be

covered with an opaque white stoneware glaze instead of a hard porcelain glaze.

(3) It appeared probable that a "semi-porcelain" or impermeable stoneware could be made with the clay, and in order to test this possibility a vessel made from a mixture of the washed clay with a proportion of "Cornish stone" was fired to a temperature of 1200° C. A very strong impermeable product of dull white colour was thus obtained. The fusibility of the "body" could be altered (as is done in the case of porcelain mixtures) by varying the proportion of "Cornish stone" and by the addition of silica.

(4) The same substances, viz. clay, felspar, and silica, which are used for the manufacture of stoneware, are also used, in different proportions, for the production of "felspathic faience," which is a white ware, sometimes impermeable and slightly translucent and thus resembling porcelain. The present clay would probably be suitable for this purpose.

Trials for Production of Refractory Bricks

In order to ascertain whether refractory bricks could be made from the unwashed clay, a number of bricks were made and fired to a temperature of 1560° C., when it was found that vitrification had taken place, with considerable blistering, probably owing to the presence of felspathic particles. The shrinkage was about 7·5 per cent. It is evident, therefore, that the unwashed material is unsuitable for the manufacture of refractory bricks.

Trials showed that the washed clay, on being fired to a temperature of 1560° C., also undergoes partial vitrification, but, in this case, no softening or blistering was observed. It therefore appeared probable that if the washed clay (preferably in admixture with grog [1]) were used instead of the crude clay for the production of refractory bricks the blistering would not occur. Mixtures were accordingly made of the washed clay with (*a*) 30 per cent. and (*b*) 50 per cent. of grog respectively, and bricks made with these mixtures were fired to about 1570° C. Strong vitrified

[1] Washed clay which has been fired to a temperature of about 1600° C. and then ground to pass a sieve having 20 meshes per linear inch.

bricks were thus produced, which showed no signs of blistering. Slight warping had taken place in the case of the brick made with 30 per cent. of grog, but no sign of deformation or softening was apparent in the brick containing 50 per cent. of grog. The shrinkage in the case of the 50 per cent. mixture was about 7·8 per cent.

The washed clay thus appears to be suitable for the manufacture of refractory bricks for use in the kilns employed for the production of pottery or stoneware, but it is unlikely that it could be made to yield first-grade refractory bricks, which (according to the requirements of the Institution of Gas Engineers) have to withstand a temperature of 1680° C. without showing any sign of fusion.

Conclusions

The foregoing results indicate that this clay, after washing, is suitable for the manufacture of white permeable pottery, which can be glazed to yield a fine white earthenware. It is not suitable for the manufacture of hard porcelain, but could probably be used in conjunction with suitable felspathic and siliceous materials for the production of " semi-porcelain " or impermeable stoneware.

The washed clay would also be suitable, when mixed with grog, for the production of second-grade refractory bricks.

It was pointed out, in forwarding this report to the Australian authorities, that if it is proposed to utilise this clay in Australia for the manufacture of " semi-porcelain " or impermeable stoneware, it would be desirable to have further trials made with the clay in conjunction with the felspathic and siliceous materials which it is intended to use for the purpose, and that the Imperial Institute would be glad to carry out this additional work on receipt of suitable amounts of the clay and the other materials.

SPECIAL ARTICLE

THE PRESENT POSITION AND PROSPECTS OF COTTON GROWING IN THE NORTHERN PROVINCES OF NIGERIA

By P. H. Lamb

Mention has from time to time been made in this Bulletin (1905, **3**, 49; 1909, **7**, 158; 1913, **11**, 70, 656) of the work which has been conducted by the Agricultural Department of the Northern Provinces of Nigeria, with the object of developing the cotton-producing potentialities of that territory. When the Department came into being in 1912 the only types of cotton in cultivation were of indigenous origin. These were found to be for the most part of poor yielding capacity and of low ginning percentage, while the lint was rough and short. The problem in the first instance was therefore to find a variety of cotton better adapted to the needs of the grower and spinner alike. Careful trials were made, as a result of which it was decided to concentrate effort upon a strain of "Allen's Long Staple Upland" which had already been acclimatised by the writer in Uganda.

This preliminary work necessarily occupied several seasons, but from these small beginnings the growth has been rapid, until last season the improved type of cotton was grown to the exclusion of all other varieties throughout the entire Zaria Province and adjoining areas, and produced a crop of upwards of 8,000 bales. The centre from which this work has been carried on has been the Maigana Experimental Station, near Zaria. The close co-operation of the British Cotton Growing Association, whose main ginnery is situated at Zaria, has been essential to the success of the undertaking.

The natives themselves are so appreciative of the advantages to be derived from the use of the improved seed that the work has met with the increasing support of the chiefs without whose assistance our efforts could hardly have succeeded. Undoubtedly the season 1920–21

has been the most favourable one in our experience. The rains throughout the cotton-belt began early, and were well maintained until the end of October, instead of ending abruptly with September as is generally the case. This meant that the later sown cotton yielded an appreciable crop instead of being prematurely dried up by the Harmattan wind.

At Ilorin, which is some 200 miles nearer the Equator than Zaria, and where the rainfall normally extends to the end of October, it has been found that the heavy rains and cloudy weather usual in August and September are highly injurious to cotton in the flowering stage. An effort was therefore made to secure a crop of Allen's Long Staple by delaying sowing until September. This practice, though unsuited to cottons of the indigenous type which are of slower maturing habit, has given very promising results. Hitherto the importance of cotton as an article of export from Nigeria has been somewhat dwarfed by that of ground nuts, which, owing to the war, had commanded locally as high a price as £40 per ton. As a result of this boom price the natives last season concentrated their attention on this crop to such an extent as actually to reduce the area devoted to cotton. The yield per acre of the latter was, however, distinctly above the average.

In the latter part of 1920 the economic position was entirely reversed owing to the following causes:

(1) The price of ground nuts fell to £6 per ton.

(2) The price offered by the British Cotton Growing Association for Allen's Long Staple seed-cotton rose locally from $3\frac{3}{4}d.$ to $4\frac{1}{2}d.$ per lb.

(3) The price of imported manufactured cloth dropped 50 per cent.

The native was not slow to adjust himself to these violent fluctuations of the market, with the result that a larger proportion of the crop than ever before was offered for export. This rush on the part of the native to sell was of course due to the unprecedented price which the British Cotton Growing Association were offering, accompanied as it was by a slump in the price of all other local commodities, and a heavy and sudden fall in the

price of imported cloths, which for the moment cut the feet from under the local spinning industry. That this was so is proved by the fact that for the first time on record some hundreds of tons of seed-cotton have come to the ginnery at Zaria from Kano—a market hitherto unattracted by the prices offered by the Association. The prices recently paid in Nigeria are unfortunately likely to involve a heavy loss. The Association, however, rightly felt that it would have been a breach of faith with the native not to pay the figure promised some months previously. Personally I have always been opposed to the guaranteeing of a price for cotton.

I consider that the best and soundest economic interests will be served when the price paid locally is the highest consistent with the prices ruling on the home market. It is not as though the native had to sink much capital in the enterprise and required to be indemnified against loss. No such need arises, for cotton is in the majority of cases merely a subsidiary crop, which, if not required by Lancashire, will be readily absorbed at a remunerative rate by the local spinning industry, which is everywhere in evidence.

Last season the area devoted to long-stapled cotton was further extended by the inclusion of certain parts of the Sokoto Province which lie to the north-east of Zaria. As usual the aid of the native Administration was sought in order to make sure that no indigenous cotton should be grown in proximity to the improved type. Careful inspection and enquiry proved that this end had been achieved, but that it had resulted incidentally in reducing the area under cotton in these districts by some 50 per cent. This falling-off was caused partly by individual prejudice on the part of the growers who were ignorant of the merits of the new seed, and partly by difficulties of seed distribution over wide areas far removed from the ginning centre at Zaria—100 miles away.

Consideration of these points, together with the inadvisability, from an administrative point of view, of introducing a totally new variety of cotton to the compulsory exclusion of other time-honoured local varieties, has led me recently to advocate rather a different mode

of procedure. It is proposed in future to introduce the improved seed, though not necessarily to the exclusion of indigenous varieties. The necessity of avoiding mixing will, however, be duly impressed upon all concerned, and it will be the duty of inspectors to see that no such mixing takes place. At the picking season a few special markets will be gazetted where long-stapled cotton will be purchased at a premium. No person will be under any obligation to bring cotton to such markets to be inspected, but ginners will be requested to co-operate by refusing to pay the premium offered for long-stapled cotton unless and until such cotton has been duly inspected at a gazetted market. The seed from such districts will not, however, be used for distribution until growers are so convinced of the relative merits of long-stapled cotton as to adopt it to the exclusion of the indigenous types. In this way the danger of distributing hybrid seed will be avoided.

While fully realising the advantages of large central ginneries situated on the railway, I am none the less convinced that if cotton cultivation is to prosper in districts more than fifty miles from a railway station, it will be essential to open up subsidiary ginneries, connected to the railway by means of motor roads. Already a suitable site for such a ginnery exists at Gusau, 120 miles from Zaria along the motor road in the direction of Sokoto. It cannot be economically sound to carry seed-cotton (containing only 30 per cent. of lint) by road for such a distance and then to return the bulk of the seed again for sowing. Cotton production can never go ahead with so serious a handicap as this. Attention has repeatedly been drawn to the fact that it is the enormous charges involved in buying, ginning, railway transport, freight, insurance, brokerage and interest on money, in dealing with the raw material, and again a corresponding set of charges in connection with the retailing of the manufactured cloth which enable the local spinner and weaver to compete with Lancashire to the great detriment of our export and import trade. I am convinced that the export of cotton from Nigeria will never develop on a really large scale until all these charges are cut far finer

than at present. If steps are not taken to this end I anticipate that cotton mills will soon be started in Nigeria as has been the case in India.

These are points for the manufacturer to consider. The agriculturist's part is to increase the yield per acre, to increase the ginning percentage and to improve the quality of the lint. Already we have made notable progress in these directions, but our work is still in its infancy. It is satisfactory to report that the yields of our selected cottons this season average something like 700 lb. of seed-cotton per acre, while nine years ago 250 lb. per acre was the highest yield then recorded. We have this year also the finest individual selected plants which I have ever seen in West Africa. It is merely a question of segregation and propagation to get these selected strains established throughout the cotton-producing areas of the North. This can only be done by means of a suitable staff to supervise the distribution, cultivation, marketing and ginning of such improved types.

In so large a country as Nigeria, with its differing soils and climates, it is hardly likely that the type of cotton evolved at one centre will prove to be the ideal for all, though it may none the less be an improvement on existing types. Hence it will be necessary, in the best interests of cotton cultivation, that each ginnery should be regarded as a separate distributing centre for the district which it serves.

With regard to the future prospects of extending the area under cotton in Nigeria, it will be clear from what has already been said that the question as to whether the native will adopt cotton cultivation on an increasing scale is purely an economic one. At present the social system of Nigeria is wonderfully self-contained, and there are many alternative ways open to the native of acquiring wealth other than by cotton cultivation. Reports have in recent years appeared in the Press to the effect that, were a railway opened to Lake Chad, large quantities of cotton might then become available for export. It is difficult, however, to understand on what grounds such opinions are based. Recently I had an opportunity of visiting this most interesting region and was intensely impressed by

its possibilities as a grain-producing country, but failed to see how large quantities of cotton could be grown. It is true that small cotton plots are frequently seen throughout the district, but the condition of their cultivation was little short of lamentable. This state of affairs was the more remarkable in view of the fact that small lots of seed-cotton offered for sale in the local market were fetching as much as 3*d*. per lb.—a price which could not possibly be paid in normal times were such cotton purchased for export. From the climatic point of view it would also appear that the prospects of cotton in Bornu are anything but hopeful. The rainfall is in the neighbourhood of 20 in. per annum, and the energy of the natives is pretty fully occupied during the rainy season in raising sufficient food crops to meet their needs. On the shores of Lake Chad there is practised a very specialised type of basin irrigation. Here, when the flood waters recede in January, seed of various kinds, but consisting mainly of millets and cow-peas, is sown. The resulting crops ripen some three months later without the aid of either irrigation or rainfall. Small quantities of cotton seed are also sown. Owing, however, to the cold dry wind experienced at night at this time of year the growth of the cotton plants is very slow, and the natives do not appear even to take the trouble to single them but allow them to grow in clumps and form a sort of shrub. In this neglected fashion the plants exist until, with the aid of the following season's scanty rainfall, they ripen a small crop. The plants are seldom uprooted until the land is required for another crop. At the time of my visit there were several such old neglected plots to be seen. Two varieties of cotton were noticed. These are known in the vernacular as "bulum" and "leno." The former was identified as *Gossypium obtusifolium*, Roxb., and the latter as *G. punctatum*. The bolls of neither of these varieties were larger than acorns; the lint was very sparse, and about ¾ in. long. It would in all probability not be difficult to improve the standard of cotton cultivation around Lake Chad, and to introduce an improved variety of seed, but it is improbable that much of the resulting crop would find its way to Lancashire.

GENERAL ARTICLE

THE WORLD'S TRADE IN SUGAR, WITH SPECIAL REFERENCE TO THE EMPIRE

In a previous number of this Bulletin (1921, **19**, 26) an account was given of the cultivation of the sugar-cane and the manufacture of cane sugar.

In the present article the world's production and consumption of both cane and beet sugar are dealt with, special attention being given to the position and prospects of sugar production in countries of the British Empire.

As in the case of the previous article, the Imperial Institute is indebted for the preparation of the groundwork of this article to Mr. A. H. Kirby, Director of Agriculture, Tanganyika Territory, lately Assistant Director of Agriculture, Southern Provinces, Nigeria, and formerly Scientific Assistant, Imperial Department of Agriculture, West Indies. Mr. G. C. Dudgeon, C.B.E., lately Consulting Agriculturist to the Government of Egypt, has kindly given assistance in revising certain sections, particularly that relating to Egypt (page 507).

The World's Sugar Production

Prior to the war about three-quarters of the world's sugar was produced by eight countries, which in the five-year period 1909–10 to 1913–14 contributed the following approximate average percentages of the mean total for the five years.

Country.	Kind of sugar.	Percentage of total world's sugar production.
India	Cane	13·8
Cuba	"	12·0
Java	"	7·8
United States	Cane 1·6 Beet 3·3	4·9
Germany	Beet	13·4
Russia	"	10·3
Austria-Hungary	"	8·6
France	"	4·4

The serious effect of the war on the beet-sugar industry of Europe is shown in the following table, giving the

corresponding figures for the same eight countries during the period 1914–15 to 1918–19.

Country.	Kind of sugar.	Percentage of total world's sugar production.
Cuba	Cane	18·9
India	"	16·0
Java	"	9·0
United States	Cane 1·2, Beet 4·2	5·4
Germany	Beet	10·4
Russia	"	7·5
Austria-Hungary	"	6·1
France	"	1·1

The large increase in the production of cane sugar which took place in Cuba and Java owing to the shortage of beet sugar was also exhibited in the case of other cane-producing countries. The detailed figures of production for four five-year periods ending 1918–19 are shown in the table on page 477, in which the countries are arranged according to their average output in the period ending 1913-14.

Comparing the percentage figures for the first three quinquennial periods, it is seen that the production in the following countries kept more than abreast of the world's increase of production, namely: Cuba, Russia, the United States, Hawaii, Porto Rico, Italy, Formosa, Philippine Islands, Mexico, Denmark, Haiti and San Domingo, Natal, and Fiji; that is to say that the proportionate increase of production was steadily greater in these than in any of the other countries. It is noticeable that seven of these countries (including the United States itself) are places where the sugar industry is largely or completely under the influence of the United States. Only four of them are countries where beet sugar is grown to any extent; three of them are European countries; and lastly, two of them are British possessions. The outstanding feature of the table is the enormous increase shown in the Cuban output.

Java, the Netherlands, the Argentine Republic, Peru, Spain and Martinique are countries where the increase of production during the fifteen years kept more or less steadily level with the increase in the world's production. On the other hand, most of the countries (thirteen in number) not already mentioned in the present connection

World's Production of Sugar (C = *Cane*, B = *Beet*)

	1899–1900 to 1903–4.		1904–5 to 1908–9.		1909–10 to 1913–14.		1914–15 to 1918–19.	
	Average amount.	Average per-centage.	Average amount.	Average per-centage.	Average amount.	Average per-centage.	Average amount.	Average per-centage.
	Tons.		*Tons.*		*Tons.*		*Tons.*	
British India (C)	2,049,410	16·71	2,014,800	14·20	2,328,440	13·80	2,701,289	15·95
Germany (B)	1,925,952	15·69	2,059,600	14·51	2,257,644	13·38	1,759,757	10·39
Cuba (C)	788,289	6·43	1,269,073	8·94	2,022,464	11·98	3,208,432	18·94
Russia (B)	1,045,973	8·53	1,339,693	9·44	1,738,819	10·30	1,261,698	7·45
Java (C)	869,180	7·09	1,115,261	7·86	1,313,120	7·78	1,519,708	8·97
Austria (B)	845,821	6·89	1,081,208	7·62	1,032,714	6·12	} 1,046,651	6·12
Hungary (B)	255,031	2·08	276,052	1·95	421,527	2·50		
United States (C and B)	402,964	3·28	664,381	4·68	825,152	4·89	922,648	5·45
France (B)	976,243	7·96	794,836	5·61	747,885	4·43	186,682	1·10
Hawaii (C)	291,259	2·37	417,621	2·94	504,426	2·99	547,308	3·23
Porto Rico (C)	77,236	0·63	197,559	1·39	319,506	1·89	392,931	2·33
Brazil (C)	275,684	2·25	223,588	1·58	257,196	1·52	212,925	1·26
Belgium (B)	250,391	2·04	281,031	1·98	257,316	1·52	131,597	0·78
Netherlands (B)	164,591	1·34	202,721	1·43	242,402	1·44	237,424	1·40
British West Indies and British Guiana (C)	275,874	2·25	254,370	1·79	205,185	1·22	177,289	1·05
Mauritius (C)	170,419	1·39	180,168	1·27	201,380	1·19	235,829	1·39
Australia (C)	125,599	1·02	182,157	1·28	199,490	1·18	226,606	1·34
Italy (B)	75,528	0·62	119,854	0·84	196,053	1·16	148,676	0·88
Formosa (C)	33,105	0·27	69,702	0·49	177,916	1·05	365,994[2]	2·16
Philippine Islands (C)	74,164	0·60	127,518	0·90	172,160	1·02	230,808	1·36
Argentine Republic (C)	133,635	1·09	136,993	0·97	164,764	0·98	157,458	0·93
Mexico (C)	84,194	0·69	115,752	0·82	147,983	0·88	67,000	0·40
Peru (C)	124,454	1·01	153,632	1·08	147,010	0·87	276,099	1·63
Sweden (B)	98,910	0·86	119,711	0·84	136,974	0·81	137,426	0·81
Spain (B)	71,082	0·58	93,111	0·66	110,176	0·65	121,351	0·72
Denmark (B)	45,806	0·38	57,907	0·41	110,166	0·65	134,440	0·79
Haiti and San Domingo (C)	46,400	0·38	62,331	0·44	94,738	0·56	130,685[3]	0·77
Natal (C)	25,545	0·21	36,257	0·26	81,661	0·48	124,105	0·73
Fiji (C)	41,335	0·34	58,307	0·41	75,284	0·45	92,700	0·55
Japan (C)	53,170	0·43	54,317	0·38	62,647	0·37	—[4]	—
Egypt (C)	88,456	0·72	52,752	0·37	58,960	0·35	86,384	0·51
Guadeloupe (C)	37,830	0·31	34,925	0·25	39,983	0·24	33,375	0·20
Martinique (C)	31,533	0·26	36,536	0·26	39,300	0·23	28,662	0·17
Réunion (C)	37,997	0·31	33,750	0·24	37,804	0·22	40,029	0·24
Chile (C)	33,924	0·28	—[1]	—	—[1]	—	—[1]	—
Average total estimated production	12,267,320	—	14,189,990	—	16,879,182	—	16,943,966	—

[1] *Information not available. Sugar production reported to have greatly decreased.*
[2] *Including Japan.* [3] *Figure for* 1918–19 *only.* [4] *Included with Formosa.*

had a production that has not undergone an increase commensurate with the increase in the world's production during the fifteen years; British India, Germany and France are examples of large sugar producers included in this category. Austria and Australia had an increased proportionate production in the second five-year period, which was not maintained in the third.

It will be seen that India is the only British possession

occupying an important place in the list of sugar-producing countries. The output from the whole of the rest of the Empire was less than that of Austria, and was gradually declining in proportion to other countries of the world up to 1913–14, although there was a slight recovery in the last quinquennium shown in the table. The position in regard to the chief sugar-producing British possessions is shown at a glance by the following figures taken from the table:

	1899–1900 to 1903–4.	1904–5 to 1908–9.	1909–10 to 1913–14.	1914–15 to 1918–19.
British India	16·71	14·20	13·80	15·95
British West Indies and British Guiana	2·25	1·79	1·22	1·05
Mauritius	1·39	1·27	1·19	1·39
Australia	1·02	1·28	1·18	1·34
Natal	0·21	0·26	0·48	0·73
Fiji	0·34	0·41	0·45	0·55
Egypt	0·72	0·37	0·35	0·51
Total percentage	22·64	19·58	18·67	21·52

World's Consumption of Sugar

The United States and the United Kingdom are the chief importers of sugar. The total quantity imported into the United States in 1920 reached the record figure of 4,224,000 tons. An approximate estimate of the production of cane and beet sugar in the country for that year amounts to 755,000 tons, and allowing for exports, the total consumption was 4,340,000 tons, representing a *per capita* consumption of 91·5 lb., and more than one-fourth of the total world's production. The United States obtains the greater part of its supplies from Cuba. In 1913 the total consumption was 3,675,000 tons, or 85·3 lb. *per capita*, and one-fifth of the world's production.

The consumption of sugar in the United Kingdom fell considerably in 1920, the total amount being 1,347,000 tons as compared with 1,565,000 tons in 1919 and 1,941,000 tons in 1913. The *per capita* consumption in 1913 was 94·5 lb. as compared with 65·6 lb. in 1920.

The figures given in the table on page 479 presenting summary details of the sugar imports into the United

Imports of Sugar into the United Kingdom

—	1911.	1912.	1913.	1918.	1919.	1920.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Refined Sugar						
Foreign Countries	906,170	798,755	922,255	12,033	372,634	112,438
British Possessions	31,056	12,087	290	9,518	89,499	7,374
Unrefined Sugar						
Beet						
Foreign Countries	506,916	362,959	677,106	7,691	0·8	15,147
Cane and other sorts						
Foreign Countries	277,710	448,160	297,880	1,066,024	861,974	946,348
British Possessions	176,459	95,615	71,729	210,382	280,528	290,049
Total Unrefined						
Foreign Countries	784,626	811,119	974,986	1,073,715	861,795	961,495
British Possessions	176,459	95,615	71,729	210,382	280,528	290,049
Sugar, total quantity						
Foreign Countries	1,690,796	1,609,874	1,897,241	1,085,748	1,234,429	1,073,933
British Possessions	207,515	107,702	72,019	219,900	370,027	297,423
Total quantity	1,898,311	1,717,576	1,969,260	1,305,648	1,604,456	1,371,356
	£	£	£	£	£	£
Sugar, total value						
Foreign Countries	23,506,528	23,540,975	22,135,688	27,231,868	39,433,835	55,482,726
British Possessions	3,080,311	1,608,686	930,933	7,179,409	14,494,033	17,657,730
Total value	26,586,839	25,149,661	23,066,621	34,411,277	53,927,868	73,140,456

Kingdom during the three years preceding the war and the three years 1918–20, according to their British or foreign origin, serve to demonstrate the well-recognised fact of the very large dependence of this country on foreign countries for sugar supplies.

The share of the British possessions in the imports into the United Kingdom was less than 4 per cent. in 1913. Prior to the war refined sugar always formed between two-fifths and one-half of the total imports, and of this an inconsiderable proportion came from British sugar-producing countries. The quantity of unrefined beet was from about one-fifth to one-third of the total. Unrefined sugar other than beet, chiefly cane, of course, accounted in 1912 for nearly one-third of the imports; in 1911 and 1913 it was replaced largely by unrefined beet, especially in the latter of these years. The share of the British sugar-producing countries in the imports of unrefined sugar other than beet was abnormally high in 1911, being about two-fifths.

The effect of the war was to increase the share of the British possessions in the supply of sugar to the United Kingdom. Unrefined beet disappeared, of course, from the imports; and the fact of its incomplete replacement by unrefined cane sugar, together with the circumstance of a natural decrease in the shipments of foreign refined sugar, led to a total importation in 1918 that was about one-third less in quantity than that of 1913.

In 1913, when the importations of sugar into the United Kingdom may be taken as being typical of the sugar supply before the war, more than four-fifths of the sugar entering this country came from European states, Germany contributing the greatest share, namely, nearly three-fifths of this proportion, or somewhat less than one-half of the whole supply; Austria-Hungary came next with nearly one-fifth of the total imports, followed by the Netherlands with about one-tenth. Cuba was the largest supplier among countries not in Europe, its share being a little greater than that of the Netherlands. Of the countries not yet mentioned, Belgium contributed about two and a half per cent., and the British West Indies and British Guiana together about the same amount. Notwithstanding

that Mauritius exports more sugar than any other British possession, this colony only supplied about one per cent. of the imports into the United Kingdom in the year mentioned, because of its large sugar trade with India, the Union of South Africa, Ceylon and Australia which existed at that time. Among the importations from this island was the only white sugar, entirely produced in a British colony, coming to the United Kingdom.

India is not only the greatest producer of sugar among British possessions, but also the greatest consumer, having only a small export and at the same time larger imports than any other country in the Empire: from 1911 to 1913 the imports rose from about 500,000 to just over 800,000 tons; in 1914, however, they dropped to about 400,000 tons, and have since risen again only to 500,000 tons in 1915 and 1918. Other British possessions which have a significant sugar production together with a notable importation are Australia and the Union of South Africa. Ceylon forms an example of a British possession in the tropics where, although sugar-cane flourishes, there is no production of sugar of any account, but on the contrary a quickly increasing importation which in 1913 had reached nearly 27,000 tons. Canada has a large importation which now amounts to more than 300,000 tons; it has consisted largely of sugar from the West Indies and British Guiana for refining. Among the other British possessions, New Zealand has imported sugar to an amount of about 60,000 tons annually in recent years. The table on page 482 gives further information regarding these matters, and indicates, among other things, that the demand for sugar in the West African possessions has not yet attained any magnitude, in spite of the comparatively large population of some of those countries.

Foreign countries, other than the United States, having a large import of sugar, arranged in order of importance according to the quantities imported in 1912, are: France (over 300,000 tons), China (over 200,000 tons), Japan and Switzerland (each over 100,000 tons), Persia, Netherlands and Chile (each over 50,000 tons), Norway, Portugal and Uruguay (each over 20,000 tons), Siam, Denmark, Bulgaria and Argentine Republic (each over 10,000 tons).

Imports of Sugar into British Possessions

—	1911.	1912.	1913.	1917.	1918.	1919.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
British India [1]	507,092	673,593	802,978	470,673	506,684	408,723
Canada	289,014	335,259	352,143	327,797	342,799	320,974
Straits Settlements [2]	64,398	106,162	99,181	189,787	198,111	97,340
Australia	33,276	98,481	74,862	15,805[3]	52,569[3]	112,805[3]
New Zealand	55,318	60,651	61,487	66,220	49,718	57,320
Egypt [4]	45,045	34,499	32,417	10,748	18,172	12,313
Ceylon	18,695	21,339	26,913	18,283	17,941	19,510
Union of South Africa	32,609	17,307	26,095	11,287	18,919	2,524
Federated Malay States	12,056	13,219	14,962	9,874	8,183	9,896
Newfoundland [1]	3,683	4,796	5,920	3,993	5,617	6,239
Malta [1]	5,049	5,086	4,682	5,043	2,745	2,583
Kenya Colony and Uganda [1]	2,519	3,973	4,511	4,412	3,950	—
Gold Coast	1,547	1,914	2,949	804	83	1,087
Rhodesia	2,162	2,608	2,693	2,742	2,269	2,341
Nigeria	1,146	1,271	1,929	582	107	427
Cyprus	1,429	1,613	1,744	1,213	1,159	1,328
Sudan	1,164	1,353	1,581	1,097	1,276	1,300
Somaliland [1]	708	1,035	1,282	889	—	669
British North Borneo	955	1,095	1,074	1,071	1,237	947
Gambia	604	252	960	199	126	275
Bermuda	793	953	856	858	1,021	730
Sierra Leone	537	567	624	197	256	260
Seychelles	256	300	337	268	370	273
Nyasaland [1]	—[5]	—[5]	—[5]	135	326	82

[1] *For fiscal years* 1911–12, *etc.* [2] *Largely Java sugar for re-shipment.*
[3] *For fiscal years* 1917–18, *etc.* [4] *Largely raw sugar for refining.*
[5] *Weight not recorded.*

The following table shows the consumption of sugar *per capita* in 1913 in the United Kingdom, India, the United States and the principal European countries.

	lb.		lb.
United Kingdom	94·5	France	43·9
India	22·3	Belgium	36·1
United States	85·3	Austria-Hungary	29·2
Denmark	95·6	Russia	25·4
Switzerland	73·6	Turkey	21·9
Sweden	57·7	Portugal	14·7
Netherlands	50·1	Spain	14·2
Norway	46·6	Italy	11·7
Germany	45·1		

Position and Prospects of Sugar Production in Countries of the British Empire

India

Although one of the countries of chief importance for sugar production, British India has now become a country

of small significance as regards the supply to other lands: in 1890 the exports were as much as 72,000 tons, whereas in 1913–14 they were only 9,597 tons, valued at £91,649. There has, however, been no great general fall in the exportation of Indian sugar since 1900, when the shipments amounted to 14,889 tons; during the war the exportation was as low as 4,265 tons in 1915–16, but rose to 13,408 tons in 1916–17, and since the war has increased to 22,166 tons in 1920–21. Ceylon for many years past has been a regular customer for the lower qualities of Indian sugar, taking, as a rule, from 2,000 to 4,000 tons a year, and occasionally larger quantities, as in 1916–17, when over 10,000 tons were sent there. The quantities exported to other countries vary from year to year, the United Kingdom sometimes taking large quantities of the lower grades (nearly 12,000 tons in 1920–21), whilst Asiatic Turkey and Persia are usually the chief purchasers of the better qualities.

The average annual production of raw sugar from the sugar-cane in India for the five-year period ending 1919–20 was 2,835,000 tons, the maximum for the period being 3,388,000 tons in 1917–18; it has risen to this quantity, with fluctuations, from about 1,860,000 tons in 1899. The area under sugar-cane was estimated in 1918–19 to be 2,861,000 acres, but since then the area has declined to 2,686,000 acres in 1919–20 and 2,553,000 acres in 1920–21. The estimated area in 1921–22 was still less. These figures refer only to British India (but not including Burma, Delhi and Ajmer), native states in Bombay and the Baroda State. The average yield of raw sugar per acre was about 2,500 lb. in 1919–20, the highest yields being obtained in Madras (6,359 lb.) and Bombay and Sind (5,236 lb.). In the following year the average was reduced to 2,163 lb. per acre owing to deficient rainfall in some of the important cane-producing provinces.

In 1920–21 the total area under sugar-cane in British India was distributed in the following proportions: United Provinces (Agra and Oudh) 52·4 per cent., Punjab 16·5, Bihar and Orissa 10·5, Bengal 8·7, Madras 4·2, Bombay and Sind 3·1, Assam 1·4, North-West Frontier Province 1·3, Central Provinces 0·9. The remaining 1 per cent.

was shared by Burma and other administrations (Delhi, Berar, Ajmer-Merwara, Manpur Pargana and Coorg).

The production of sugar in Madras, Bengal, Upper Burma and Sind is assisted to a large extent by the yield from plants other than sugar-cane. In Madras the area under such plants is over 90,000 acres, or three-quarters as much as that under sugar-cane; in Bengal it is nearly one-third as great, and in Sind nearly two-thirds; whilst in Upper Burma the area devoted to sugar-cane is only about one-sixth of that occupied by other plants that yield sugar. Among these sugar-yielding plants the chief are: the date palm (*Phœnix sylvestris*), mainly in Eastern Bengal, Madras and Bombay; the palmyra palm (*Borassus flabellifer*), in Madras, Burma and Mysore; the coconut palm (*Cocos nucifera*), chiefly in Madras; and the Indian sago palm (*Caryota urens*), mainly in the Bombay Presidency, where, however, sugar from sources other than the sugar-cane is only produced to a very small extent.

As is seen, most of the sugar produced in India is used in the country; it has been consumed mainly in the form of the raw product, called gur, gul or jaggery, but in recent years there has been a rising demand for refined sugar. In 1913–14, 802,978 tons of sugar, valued at £9,525,678, were imported, the chief sources being Java (582,995 tons), Mauritius (139,569 tons) and Austria-Hungary (74,001 tons). Since that year the imports have decreased considerably, varying from 515,910 tons in 1915–16 to 408,723 tons in 1919–20. Java still remains the chief source of supply, and in addition to the direct shipments, large quantities of Java sugar are imported via the Straits Settlements.

It will be observed that sugar-cane growing is much more widespread in Northern than in Southern India; and it is in the northern part of the country that the best opportunities are afforded for an increase of production, notwithstanding that the climate of the southern and tropical part of the peninsula produces the best canes.

Among the principal experimental investigations in India in connection with sugar production, there are the researches in cane breeding at Coimbatore and Bihar, and the work of a more immediately practical nature at

Shajahanpur—a sugar experiment station subserving the interests of sugar in Northern India. Further, there are being conducted in various places tests of varieties of sugar-cane proved to be useful in other countries: the best general success with such varieties has been obtained in Madras and the Mysore State; and encouraging progress has been made with improved varieties in Assam. The extension of the employment of mechanical means for cane cultivation has received considerable attention at Kamrup in Assam. The improvement of ordinary cultural methods has been the principal consideration in Bombay, at the Manjoi sugar-cane farm, and in the irrigated area of the Deccan; as well as in the Central Provinces, at the Sindewahi farm in the Chanda district. Experiments with a view to extending the cane-growing area in Burma, conducted in the district near the Mon Canal, have given satisfactory results.

In view of the conditions of the cane-sugar industry in India, the chief efforts in regard to the improvement of the methods of the manufacture of sugar in that country have been made in the direction (1) of devising improved means, suitable for the small cultivator, for turning out either gur or sugar at will, (2) of replacing bullock power for turning mills by that from small oil engines, and (3) of providing more economical furnace work in the manufacture of gur from the cane juice from the improved mills, especially in Mysore, Madras and Bombay.

This very general account gives a mere indication of the large amount of experimental work with sugar-cane and sugar that is being done in India, and does not include the important investigations that are being made in regard to the production of sugar from sources other than sugar-cane, such as the date palm and sugar beet.

A Sugar Bureau was instituted at the beginning of 1919, for the purpose of collating and disseminating information relating to the Indian sugar industry, and towards the close of that year the Indian Sugar Committee was appointed to investigate the whole question of the industry. The views of the Committee have just been published in a lengthy *Report*, which will be dealt with in detail in a subsequent number of this BULLETIN.

Ceylon

Although sugar-cane grows well in Ceylon, there is no sugar industry of any importance in the island; only about 450 acres are planted, and the resulting canes are used for chewing and for a small production of a crude sugar like the gur of India; the imports supplying the needs of the island come chiefly from Java, Straits Settlements and Hong Kong.

If an attempt is made to create a sugar industry of any consequence in Ceylon, the canes will have to be grown in the districts of least rainfall, with the employment of irrigation, as the areas of heavy rainfall are more suitable for the purpose to which they are at present applied, viz. the cultivation of perennial crops, such as rubber, cocoa and coconuts.

Mauritius

The production of sugar is the chief industry of this island, which, in spite of its small size—only 705 square miles—has a total annual output approaching a quarter of a million tons. In 1901 the production had already reached 186,725 tons, and the increase since that time has been due mainly to improved methods of cultivation and manufacture. The output during this period has been fairly regular, as is shown by the fact that in no year has it fallen below 137,992 tons (in 1905), and during the war the production was never less than 187,754 tons (in 1917). Although the relation between the production and export in different years varies to an appreciable extent, consideration of the statistics over a series of years shows that over 99 per cent. of the sugar made is sent out of the island, the remainder, with a very small importation, satisfying the needs of the country. As long ago as 1854 the exports amounted to 102,000 tons, so that in Mauritius sugar growing and manufacture are to be regarded as forming a well-established industry that has survived the economic vicissitudes shared by all the British sugar-producing possessions, as well as the calamities of nature which it has suffered. The countries supplied with sugar by Mauritius have been chiefly the United Kingdom, India

and British South Africa, smaller quantities being exported to Canada and Hong Kong.

Sugar growing in the island was probably begun during the Dutch occupation in the seventeenth century. It has now attained to such importance that in 1919, out of a total export valued at £12,652,460, raw sugar was responsible for £12,510,320, or about 99 per cent. The quantity of sugar exported in that year was 297,959 tons, which constitutes a record for the island. In 1920 the amount fell to 179,532 tons, but the value was only slightly less than in the previous year, viz. £12,463,385. The area under sugar-cane was estimated to be 170,752 acres at the end of 1919, a figure almost identical with that of the previous year. Most of the suitable land has now been taken up, but in 1920 there was an increase of about 2,000 acres under cane, due largely to land in the Black River district, formerly derelict, being planted under an irrigation scheme.

The manufacture of sugar in Mauritius by means of modern factories has reached a development such that the small owners, who are now mostly Indians who bought land freed by the "morcellement" of areas belonging to abandoned small factories, no longer make sugar, but sell their canes to the factories. The number of factories working during 1920 was 54. The *Report of the Department of Agriculture* for that year states that very considerable improvements were introduced into a number of factories during the year, and further large orders for machinery are being placed by almost all factories, so that "the coming year will witness a marked further advance in respect of the standard equipment of the average Mauritian factory."

Special attention is given to means for the improvement of furnace work, crystallisation and cane loading; and, in the field, cultivation by machinery is being extended under special encouragement from the Board of Agriculture in the island. All these efforts are made principally with a view to economising labour. Another matter receiving particular attention is irrigation for sugar-canes on hilly estates. A proposal is under consideration for the establishment of an experiment station for the study of the

problems relating to cultivation under irrigation in the Black River district, where, as already stated, an irrigation scheme is in progress, the reservoir and distributory canals of which were expected to be completed in 1921.

Departmental work in connection with the sugar-cane is concerned mainly with: the trial, production and introduction of seedling canes; manurial experiments, especially on estates; investigations into the results of irrigation on estates; studies of the yields and conditions of sugar-cane growing in different parts of the island; and investigations regarding sugar-cane pests and diseases. Work of the kind was begun at the Station Agronomique soon after 1893, and is now under the direction of the Department of Agriculture.

The large crops of sugar in recent years, combined with the great increase of prices due to the war, have contributed greatly to enhance the stability of the sugar industry of Mauritius, in which the direct production of white sugar now forms a growing part. Thus partly by an extension of the area under cane, helped by the larger employment of irrigation, and partly through improvements in the factories, the industry has been placed on a thoroughly sound basis.

Malay Peninsula

The figures for the area devoted to sugar-cane in Malaya, although only approximate, are sufficient to indicate a large decrease in sugar growing, particularly in Province Wellesley, where the plant was under cultivation by the Chinese as long ago as 1798. Sugar-cane is grown, for chewing, almost everywhere; it has been cultivated for sugar manufacture by European and Chinese owners, principally in Province Wellesley and Lower Perak (Krian district). In 1901 the area under cultivation of canes for sugar manufacture was returned at as much as 15,071 acres; but there has been a rapid decrease in the figures (which do not take account of small isolated areas of cane) to the very small return of 73 acres in 1913.

In 1899 the export of sugar from the Straits Settlements was 32,491 tons; by 1906 it had almost doubled, becoming 60,356 tons; in 1913 the export was 58,189 tons—con-

siderably less than the unusually large shipment of 160,418 tons in 1918. The shipments from the Straits Settlements consist mainly of re-exports of Java sugar. The sugar exported from the Federated Malay States, chiefly from Perak, has decreased very rapidly from 9,332 tons, of value £79,305, in 1910 to a negligible quantity.

The chief experimental work with sugar-cane has been conducted at the Botanic Gardens at Singapore and Penang; it was at the latter that the first sugar-canes were raised from seed in the Peninsula. The work, begun at Singapore as long ago as 1878, has been concerned mainly with the introduction, trial and propagation of sugar-cane varieties. Special work by the Department of Agriculture has been necessitated in connection with locusts, which have caused much destruction, particularly in Malacca.

The great and preponderating interest in the Malay Peninsula in rubber, and the large amount of attention given by the natives to rice growing, have helped to prevent the formation of any large sugar-growing industry in the country; whilst the small industry that formerly existed has now suffered virtual extinction, as has been shown. Natural conditions, however, are very favourable for sugar-cane growing, and afford scope for a large and important production.

British North Borneo and Sarawak

Although cultivation of sugar-cane for direct consumption by the natives and the Chinese is common in these countries, little has been done towards the production of the plant on an industrial scale for sugar making. The flourishing state of the canes that are grown for the purpose mentioned, both on the coast and in fairly large areas by the natives in the interior, shows that the soil is generally well suited to the crop; and the general absence of times of severity in regard to either rainfall or drought would permit an extended planting season and simplify the working of factories. These circumstances, together with the existence of extensive and useful waterways, give conditions admitting of the production of sugar in these countries on a very large scale.

Australia

The chief sugar-producing states of Australia are Queensland and New South Wales, where a small cultivation of the cane was begun in the early sixties. In about thirty-five years, namely, in 1900, the industry had increased to important dimensions, especially in Queensland, where the area in sugar-cane was about 108,500 acres; in New South Wales, where the area of available land is by no means so large, it had become about 22,000 acres. By 1912 the area of sugar-cane in Queensland had reached 141,652 acres, and the cane from 78,142 acres was used for a production of sugar amounting to 113,060 tons; whilst in the same year New South Wales possessed about one-tenth (actually 14,283 acres) of that area in sugar-cane, of which it employed 6,137 acres for producing 16,723 tons of sugar. The small beet-sugar industry of Victoria had then reached an output of 477 tons; the area under sugar-beet was 1,320 acres in 1916–17 and 1,009 acres in 1918–19. The total acreage under sugar-cane in New South Wales has fallen from a maximum of 32,927 acres in 1895–96 to 10,568 in 1919–20. In Queensland, on the other hand, the general trend has been one of increase, the area under sugar-cane for 1917–18 being the highest on record, and during 1918–19, of the total area of 171,024 acres under cane in the Commonwealth, there were 160,534 acres, or about 94 per cent., in Queensland. In 1914 the production of sugar in Queensland was 225,847 tons, an output only exceeded by those in 1913 and 1917–1918, when it was 265,092 and 327,589 tons respectively.

Although the output of sugar in Australia is on the whole increasing, it is not keeping pace with the consumption, so that the Dominion is still dependent on foreign sources for a large proportion of its supplies. The proportion of sugar produced to the net imports from abroad has varied considerably from year to year. In season 1902–3, for example, when 98,000 tons were produced, the net imports amounted to 90,000 tons. In season 1906–7 over 200,000 tons were produced, and in 1907 the exports exceeded the imports by 12,000 tons. In season 1911–12 the production fell to 187,000

tons, and in 1912 there was a net import of 96,224 tons. Again, in 1914–15, when there was the large output of 245,000 tons, the exports exceeded the imports by 5,000 tons. In the following year, on the other hand, the production fell to 159,000 tons, whilst the net imports rose to the record figure of 115,000 tons. In 1919–20 the net imports, consisting mainly of Java sugar, amounted to 110,000 tons.

In 1918 there were forty-two sugar factories dealing with sugar-cane in Queensland and three in New South Wales, the value of the output in the two states being respectively £4,037,706 and £436,202. The small number of factories in New South Wales is chiefly due to the greater tendency toward the centralisation of sugar manufacture in that state. The refining industry of Australia is virtually in the hands of the Colonial Sugar Refining Company, of Sydney, which has obtained a large part of its raw sugar from Fiji.

In Queensland, where the work of production is in many independent hands, the sugar industry is assisted by a scheme of experiment stations and of travelling instructors for sugar growers. The work of the experiment stations is concerned principally with trials and distribution of new seedlings, cultural and manurial experiments, tests of varieties of sugar-cane, trials in farmers' experiment plots, and investigations in connection with pests and diseases. The industry has suffered from the fluctuation of the prices paid to the sugar grower for his produce, and greater stability in this matter has been sought by constituting Boards for the regulation of sugar cane prices.

A Royal Commission on the Australian sugar industry was appointed in 1911, and suggestions were made regarding a minimum wage for the labour employed in sugar production. Adverse reports were given by the Commission on the beet-sugar industry of Victoria, but this industry has now been reorganised.

As is well known, sugar is produced in Australia almost entirely by the aid of white labour. There is room for expansion of the industry in the two states mainly concerned, especially in Queensland, which affords the more favourable conditions; but this expansion would have to

be very considerable before the domestic needs for sugar in the country alone were satisfied. Admirable natural conditions for the growing of sugar-cane exist in Papua (British New Guinea), and special attention has been given to the capabilities of this area for a large sugar production.

Fiji

Previous to the British annexation of these islands, in 1875, the staple industry had been cotton growing; but at that time the general depression in the cotton market, following the ending of the American Civil War, caused substitutes for the industry to be sought in the successive directions of coffee, tea, cinchona and sugar. The first three of these met with no great success; nor did sugar, until after 1878, when coolie labour was introduced and the industry began to receive the benefits of the central factory system. Since that time steady progress has been made, so that sugar production has become the chief industry of the colony (mainly in the largest islands, Viti Levu and Vanua Levu). In 1904 the area and cane production had reached 36,543 acres and 59,619 tons; in 1913 they were 48,208 acres and 98,608 tons. The industry reached its maximum during the period 1914–16. In 1914 and 1915 the official figures for the area and production of cane were 62,851 acres and 874,164 tons, and 62,308 acres and 833,883 tons respectively; whilst in 1916 over 120,000 tons of sugar were exported. The exports have since fallen to 73,000 tons in 1920.

Nearly all the sugar produced is exported, and has gone chiefly to New Zealand, Australia and Canada, where it is refined. In Fiji, where the sugar industry is practically in the hands of the Colonial Sugar Refining Company of Sydney, much of the cane has been raised by white and native settlers on fairly large estates worked with indentured labour, and by cane farmers working on their own small plots, as well as by "cane companies" cultivating blocks of land prepared and reaped by the factory to which they belong.

As in the case of Mauritius, the extension of sugar production in Fiji is to be sought mainly in means for

increasing the yields of cane in the field and for obtaining the best recovery of sugar in the factory.

Union of South Africa

The only province which possesses a sugar industry of any importance is Natal, where in 1905 the acreage in sugar-cane had become more than 45,800, and in 1911 exceeded 64,000 acres. About the year 1850 sugar-canes were first planted on any large scale for sugar making; these consisted of native canes and canes raised from material imported from Bourbon. The plant is now grown very largely for stock feeding in addition to sugar making: a circumstance that accounts for the small calculated yield of sugar from the area in sugar-cane. By 1869 the production of sugar had reached 7,823 tons; and in 1892 the opening of the goldfields, together with an immigration of Mauritius sugar planters, had stimulated the industry so that the output was now about 18,000 tons.

In 1899 the production of sugar in Natal amounted to 29,500 tons; and it did not vary much between this date and 1905, when it was 26,603 tons. Since that time the production in the Union (chiefly Natal) has increased rapidly, amounting in 1913 to 86,500 tons. By 1916–17 the total area in sugar-cane in the Union had become over 163,000 acres and the output of sugar 114,500 tons, and in 1919–20 the production increased to 169,000 tons. Most of the sugar made is consumed in the Union itself, but during the last two years for which statistics are available the local production has been greater than the demand, the excess of production over consumption being about 23,000 tons. Most of this surplus was shipped to the United Kingdom.

In Natal the cane is ready for reaping in twenty-one months, and is usually ratooned twice. It comes to maturity earlier under the more favourable conditions obtaining in Zululand, where sugar production has been encouraged by the Natal Government since about 1906.

Work with sugar-cane has been carried out by the Department of Agriculture mainly in regard to cultivation, manuring and trials of varieties; and has received chief

attention at the experiment stations at Winkle Spruit and Stanger.

The sugar factories in Natal belong mainly to two types: small factories making and sending a crude sugar to be refined at Durban, and large factories using modern methods of manufacture. The labour employed has been chiefly that of indentured Indian coolies. Sugar cultivation is restricted to the coastal districts, and the conditions of the province do not admit of a very large extension of cane growing. The sugar finds a good market in the Union, assisted as it is by the lessened competition of foreign sugars due to high freights, by preferential railway rates within the Union, and by protection from speculation provided by sugar producers themselves at the beginning of the war. The difficulty of the labour supply is the chief hindrance to expansion.

An interesting development in the Natal sugar industry is the manufacture of the motor spirit "natalite," which consists mainly of a mixture of alcohol and ether. Just over 1,000,000 proof gallons of natalite were produced in 1917.

Jamaica

Jamaica sugar first became an article of commerce in 1673, and the industry of sugar production in the island has continued ever since, although it has shared in the vicissitudes undergone by all the old sugar-growing countries. As in several of the other West Indian islands, sugar temporarily lost its importance as the chief crop, and in Jamaica, a few years ago, it only took the seventh place in the list of exports, its annual value being exceeded by that of fruit (comprising bananas, coconuts and oranges), logwood and its extract, coffee, cocoa, rum, and pimento, in this order. Notwithstanding this decrease in the manufacture of sugar, the making of rum helped to maintain interest in the industry, and in 1914 there were in Jamaica no less than sixty-one estates on which sugar products were made; and of these, twenty-six possessed a vacuum pan or triple effet, or both. The area under sugar-cane was returned in 1919 as 47,568 acres, and the export of sugar was nearly 38,000 tons (going chiefly to Canada), the

industry having recovered its stability and again taking the first place among the exports. It is stated that the sugar industry may still further increase, owing partly to the present state of the market and partly to the improved agricultural conditions.

Irrigation is necessary for sugar-cane growing in some parts of Jamaica, and a scheme for this on a fairly large scale has been completed in the Vere district. Artificial manures are in fairly general use; and cattle manure, applied by penning the animals in the cane fields, is employed, especially in the driest districts of the island where there is no irrigation.

The work of the Agricultural Department of Jamaica, with regard to the sugar industry, is concerned chiefly with the introduction, production, raising and distribution of sugar-canes; manurial experiments on estates; the working of sugar factories and distilleries; the supply of yeast cultures for the manufacture of rum; irrigation; and the investigation of pests and diseases of sugar-cane. In 1911 the Sugar Experiment Station at Kingston passed under the control of the Agricultural Department, and it was soon demonstrated that lime and nitrogen manures were useful for sugar-cane, the latter being best in the form of ammonium sulphate, whilst potash and phosphates were seldom required.

Windward Islands

St. Lucia.—After the Treaty of Paris, in 1763, which gave St. Lucia to France, French planters from St. Vincent and Grenada settled in the island, and a sugar industry was established. The subsequent changes in ownership, together with a revolution near the end of the eighteenth century, as well as other vicissitudes, interfered greatly with the development of the resources of the island; and later the depression in the sugar industry led to cocoa growing on a scale which rivalled the sugar production.

At present cocoa and sugar production form the chief industries of St. Lucia, and there is also a strong and increasing interest in limes and lime products. The sugar is principally made in four small central factories raising their own canes and also buying those grown by

peasant proprietors. Most of the sugar is exported to the United States. Sugar production attained its greatest magnitude in 1875, when the output was about 13,000 tons of muscovado sugar. The production was 5,796 tons in 1906, but since that time has, in general, been steadily falling, having decreased to 3,733 tons in 1914, rising again to over 4,000 tons in the years 1915, 1916, and 1917, but falling to 2,952 tons in 1918.

Special means for the encouragement of sugar production by small growers have been adopted in the shape of a land settlement scheme, which includes the provision of machinery for manufacture, and trials and distribution of sugar-cane varieties. An enhanced interest is now being taken in sugar production by such peasant proprietors; but although an extension of the central factory system under favourable circumstances could enable a larger crop to be dealt with, the natural conditions of the island would prevent any great increase in the cultivation.

St. Vincent.—The sugar industry of St. Vincent, once of the greatest importance, has recently almost ceased to exist: in 1875 there was a flourishing sugar production; in 1912 the shipments, 178 tons, were only 40 tons greater than the imports. In the past most of the sugar has been taken by the United States, but during the last twenty years shipments have never exceeded the 930 tons exported in 1904. No modern plant for the manufacture of sugar exists in the island. Sugar-cane growing forms a minor industry under a land settlement scheme in which a small muscovado works is maintained for the peasants by the Government. Nevertheless, hardly any sugar and but little molasses were shipped during 1913 owing to the growing of cotton and other crops in place of sugar-cane; the sugar and molasses, together with a certain amount of rum and syrup, were used chiefly for local consumption, although in that year molasses to the value of £171 was sent to other British West Indian islands and Canada.

St. Vincent, however, shared with other colonies the increased interest in sugar caused by the recent high prices, and the exports for the years 1916 and 1917 reached several hundred tons; but no very great increase in the pro-

duction was expected, on account of the lack of labour and the established position of the cotton and arrowroot industries, and in 1918 the exports fell to 141 tons.

Grenada.—Sugar production was once an important industry in Grenada, as is shown by the facts that between 1700 and 1753 the number of sugar estates in the island had increased from three to eighty-three, and that in 1787 as much as 8,777 tons of sugar were exported. After the abolition of slavery the production decreased, and in 1846 the shipments had fallen to 4,106 tons. By 1856 it was evident that cocoa growing was to replace sugar production as the chief industry, and in 1881 only 910 tons of sugar left the island. Since 1897 exports have almost ceased, and there is, on the other hand, a large importation of sugar, amounting in 1913 to as much as 1,050 tons. Thus there remains only a small manufacture of sugar and its by-products for local use, and nothing in the nature of an export industry. Sugar production receives encouragement, however, in the land settlement scheme that has been inaugurated in Grenada ; and the settlers who grow sugar-cane have been assisted by the provision of a small sugar works by the Government, and by the distribution of good varieties of cane.

The amount of land in Grenada suitable for sugar-cane growing under modern conditions is so small as to prevent sugar from taking any important place in the export markets.

Leeward Islands

Antigua.—Sugar production continues to be the most important industry in this Presidency, although cotton growing has received increasing attention in recent years. This is the second time that cotton has been grown extensively in the island, the first occasion being during the American Civil War, when this crop became for a time more important than sugar. It is estimated that there were 14,519 acres under sugar-cane in the island in 1900, whilst in 1919 there were more than 16,000 acres. In recent years the largest productions of sugar have been in 1907, 1910 and 1916, namely, 14,774, 14,085 and 18,412 tons respectively. About 96 per cent. of the sugar produced is

exported. Before 1904, when the central factory system of manufacture was introduced into the island, nearly all the sugar produced was muscovado sugar; in 1914 only 3,986 tons out of a total export of 15,345 tons were of this kind. In 1918, 8,962 tons of sugar were exported, of which only 418 tons were muscovado.

Manurial experiments with sugar-cane have been conducted in Antigua by the Agricultural Department for a number of years, and have shown that plant canes do not require artificial manures for their profitable growth in that island, provided that applications of pen manure or similar manure are made; more recent trials with artificial manures unaccompanied by pen manure tend to demonstrate that, when the rainfall is plentiful and sugar prices are high, artificial manuring with a "complete manure" (where natural manure is not available) can be profitable. Ratoon canes, on the other hand, have been shown only to benefit with applications of nitrogenous artificial manures. Other experiments than those with manures are also carried out by the Agricultural Department with sugar-cane in this island, notably with seedling varieties of cane.

Special encouragement in sugar-cane growing by the peasantry is afforded in a village settlement, where this and other crops are raised with the sympathetic assistance of the Agricultural Department.

Antigua, as well as other West Indian islands and British Guiana, has benefited as regards its sugar industry through the Reciprocity Treaty made with Canada in 1912 after the visit of the Royal Commission in 1909. The extension of the central factory system in the island has given an opportunity for increased cultivation in the south-western part. It has been estimated by the Agricultural Department that under favourable conditions the production of sugar in Antigua might be enlarged so as to admit of an average annual export of not less than 20,000 tons.

St. Kitts-Nevis.—As in Antigua, sugar production is the chief industry of the Presidency, although cotton growing has also become of considerable importance. In 1900 the area devoted to sugar-cane was estimated at 18,231

acres; in 1919 it was 16,305 acres, by far the greater proportion being in St. Kitts. The sugar export of the two islands together has been somewhat larger than that of Antigua; actually, the average export over the ten years 1905 to 1914 was 11,473 tons for Antigua and 11,998 tons for St. Kitts-Nevis. Most of the sugar used to go to the United States, but the protection afforded to the American sugar industry has put an end to the trade, and in recent years the chief market has been found in Canada, partly through the Reciprocity Treaty, and in the United Kingdom. Nearly all the sugar-cane in St. Kitts is raised on the estate system, but in Nevis there is a large peasant industry. The central factory system for sugar making was introduced into the former island in 1912; and in 1914, 6,129 tons out of a total export of 9,789 tons were vacuum-pan sugar, whilst in 1918 the corresponding figures were 7,220 and 9,105 tons.

Experiments in the manuring of sugar-cane in St. Kitts have been conducted in the same way as those just mentioned for Antigua, and have given results similar to those obtained in that island. Sugar-cane varieties also receive experimental attention in St. Kitts.

As in Antigua, it has been officially estimated that the export of sugar from St. Kitts-Nevis might be increased to about 20,000 tons, an amount nearly attained in 1902, when 16,624 tons were exported.

Dominica, Montserrat and the Virgin Islands.—Dominica no longer possesses an export sugar industry. In its early history such an industry existed from time to time, chiefly under French influence; the island suffered, however, in common with the other cane-growing colonies, at the time of the sugar depression, and the industry was replaced by cocoa growing. In the early eighties the annual exports were about 3,000 tons, in 1901 they were only 210 tons, and in 1908 they ceased with a shipment of 24 tons. Sugar-cane is still grown on a small scale, chiefly for the manufacture of rum and syrup, this industry utilising the crop from about 550 acres; but the needs of the island for sugar have to be partly satisfied by importation, chiefly from Barbados, the total imports in 1918 amounting to over 500 tons. The scarcity of labour and the natural and

economic conditions of Dominica preclude the establishment of any large sugar export industry in the island.

The sugar industry of Montserrat has been replaced by the cultivation of limes and cotton ; but a very small export of sugar is still made. In 1899 the exports were 575 tons ; since that time they have varied in different years between 1,078 tons in 1902 and 28 tons in 1918. In the eight years, 1906 to 1913, nearly 80 per cent. of the sugar produced was exported, and the 20 per cent. left as a supply for local consumption was supplemented by imports amounting to several tons. The sugar is produced on a sharing basis between the peasants, who raise the canes and manufacture the products, and the owners to whom the land for growing and the works for manufacture belong. The area now under sugar-cane in the island is about 500 acres. The existence of this small industry would facilitate an extension of output if a greater interest should arise through a better state of the market ; and the attitude of the labouring classes toward sugar growing would favour such extension. Cotton growing continues to hold, however, a strong position in the agriculture of the island, notwithstanding recent depression. A notable expansion of the present small sugar industry would add to the economic stability of the Presidency.

The Virgin Islands in British possession have no sugar export industry ; sugar is produced, however, for local needs to an extent of 25 to 30 tons per annum, and this supply is assisted by an importation amounting approximately to 40 tons.

Trinidad and Tobago

By far the greater amount of sugar produced in this colony is from canes grown in Trinidad : in 1914, of 42,514 acres under sugar-cane cultivation in the two islands, only 8,354 acres, or about one-fifth, were in Tobago. The decline of the sugar industry in the latter island is shown by the fact that in the period 1862 to 1897 the number of sugar estates had decreased from sixty-five to thirty-eight, whilst in 1914 there were only sixteen. During the fifteen years prior to 1912 the annual sugar

export of the colony was about 40,000 or 45,000 tons; in 1912 and 1913, however, it fell to less than 34,000 tons, increasing to 63,100 tons in 1917, but dropping again to 37,806 tons in 1919. In the last-mentioned year the product was exported chiefly to the United Kingdom and to other British West India islands. In the same year the sugar products exported also included rum and molasses to the value of £34,774 and £30,907 respectively, most of the molasses going to the United Kingdom and British North America. In 1919 it was estimated that the area under sugar-cane in the colony (including Tobago) was 73,546 acres, or something less than two-fifths of the area under cocoa.

Sugar-cane investigations conducted in Trinidad by the Department of Agriculture include trials of varieties and manurial experiments. The latter were begun in 1912, but they have gone far enough to indicate that in Trinidad complete manures are better for plant canes than those not supplying together nitrogen, potash and phosphates; and that such manures possess a useful residual effect as regards ratoons, especially if the latter receive a dressing of a quick-acting nitrogenous manure. Much of the cane grown for sugar making in Trinidad—in some years more than one-half of the total amount—is raised by peasant farmers, whose interests, as well as those of the large growers, receive the attention of the agricultural authorities.

In 1915 a committee of the Trinidad Board of Agriculture reported concerning the possible extension of the sugar industry of the colony as follows:

"The Committee is also of opinion that apart from the question of labour the dominant factor in any possible increase of the industry is the working capacity of the factories. To increase this and to provide additional encouragement for cane farmers, fresh capital is absolutely necessary. This would not be forthcoming without a guarantee that the market prices of sugar would be higher than during recent years. The only way in which this guarantee could be secured appears to the Committee to be that a preference should be given by the Imperial Government to sugar produced in the British Empire."

British Guiana

In spite of its many vicissitudes, sugar production is, and has been for very many years, the principal industry of British Guiana; in 1913 sugar and sugar products made up 74·2 per cent. of the value of the chief exports, excluding bullion and specie, sugar alone constituting 62·3 per cent. of this value. The provision of immigrant labour has been necessary for the working of the sugar plantations, and has been employed since the year 1840. The United States used to be the chief buyer of British Guiana sugar, but since 1903 most of the exports have been taken by Canada. The by-products of sugar made in this colony are rum and molasses and a cattle food called molascuit; the United Kingdom has taken nearly all the rum and molascuit, whilst the molasses has gone chiefly to Holland and the Portuguese possessions. There is an annual importation of sugar into the colony amounting (excluding sugar in transhipment) to about 170 tons. The area under sugar-cane was returned at 67,641 acres in 1900 and 72,527 acres in 1914; in the period 1900–1914 the smallest acreage was that of 1900 and the largest 78,968 in 1903. The greatest export of sugar was 134,876 tons in 1887; this figure includes transhipments. In 1907 to 1913 the average annual shipments, excluding transhipments, amounted to 98,578 tons; this figure would have been much higher but for the effect of the severe drought in 1912. From 1915 to 1919 the exports dropped fairly steadily from 116,224 tons to 83,140 tons.

Since the introduction of sugar making on a large scale into British Guiana by the Dutch in 1658, the industry has extended along the northern coast plain of the colony and for short distances along the valleys of the chief rivers. In recent years the number of estates making sugar has been rather under forty; most of these each cultivate an area of from 1,000 to 2,000 acres. There are also about 2,000 acres on the east coast of Demerara on which sugar-cane is cultivated by peasant farmers. Most of the plantation sugar-cane is grown on empoldered land. Returns for 1919 state the total empoldered area to be 166,749 acres, 87,612 acres being cultivated and 79,137 acres uncultivated. As has been already mentioned, in the nineties the United States was the largest buyer

of British Guiana sugar, two-thirds going to that country whilst nearly all the rest went to the United Kingdom. Later, the sugar from this colony, in common with sugar from the British West Indies, was attracted through the fiscal changes to Canada, which has become its chief purchaser under normal conditions, the other principal importing countries being the United Kingdom and the United States. The value of the rum exported is by no means inconsiderable, having been £204,140 in 1913 and as much as £491,350 in 1919.

Sugar-cane has received much attention from the Department of Agriculture, particularly in regard to the production and trial of seedling varieties, and to manurial experiments. The latter have shown that most nitrogenous manures can be profitably applied to British Guiana soils; whilst the alkaline nature of the soils renders sulphate of ammonia the most suitable for the purpose. As regards phosphates, basic slag is the best in new soils, and superphosphate in the older soils which have become alkaline; whilst lime acts favourably in improving the texture of the soil, and potash manures are not usually needed.

The prospects of the extension of the sugar industry in British Guiana were reviewed some years ago by the Director of Agriculture (this BULLETIN, 1915, **13**, 209), who drew attention to the fact that scarcity of labour in the colony interferes at present with such extension. In this connection the following statement was made: "Should any certainty arise of sugar continuing to command, as at the time of writing, remunerative prices, a very great extension of sugar cultivation would take place in the colony. It is estimated on very conservative grounds that the readily available area of land well suited for sugar-cane cultivation in the eastern part of the colony could produce 1,000,000 tons of sugar, whilst there is available land suitable for sugar cultivation in the north-western portion of the colony to increase this amount to two and a half million tons a year."

British Honduras

Although this colony was able to produce as much as 2,000 tons of sugar in the early eighties, in 1917 only

126 tons were exported. In 1913 the shipment of sugar of domestic production was but 54 tons, its value being only 0·2 per cent. of that of all the chief exports, excluding bullion and specie. On the other hand, the imports of raw sugar were of the value of £1,023 in 1913 and of £5,999 in 1914, the increase in the latter year being mainly due to a greater purchase of Guatemala sugar through the removal of the import duty. There is a production of fifty to eighty thousand gallons of rum in the colony, of which only about one-sixth is exported. In 1914 the export of raw sugar had fallen to the small amount of 29 tons; the production in that year is reported as 759 tons, chiefly in the districts of Corozal and Toledo.

The economic conditions of British Honduras do not lead to an expectation of any great expansion of the present very small sugar industry, although large areas in the colony are well adapted to cane cultivation.

Barbados

Sugar production, introduced in the middle of the seventeenth century, may be called the only staple industry of the island, although in recent years attention has been given to the growing of Sea Island cotton. The importance of the sugar industry to the colony is indicated by the fact that in 1919 the area actually under sugar-cane was estimated to be 35,000 acres, which is almost one-half of the whole cultivated area and nearly one-third of the total area of the island; the area used for sugar-cane growing is naturally greater than this, having been estimated at about 74,000 acres for that year. It is also significant that in 1913 the value of the exports from this industry accounted for over 95 per cent. of the total value of the domestic agricultural produce (sugar-cane products and cotton). In that year, in the value of all the chief exports from the island, excluding bullion and specie but including bunker coal and other trade products in transit, sugar and sugar products had a share amounting to nearly 57 per cent.

The sugar produced in the island in proportion to the quantity of cane cut for sugar works has decreased since 1904 owing to the manufacture of large amounts of "fancy molasses," which is made directly from the juice of the

cane and is not, like ordinary molasses, a by-product in sugar making. During the last twenty years the values of the shipments of sugar products manufactured in the island have varied between £396,294 in 1903 and £3,513,576 in 1920. The latter figure is made up of £2,203,052 in respect of sugar and £1,310,524 in respect of molasses. The maximum quantity of sugar exported in recent years was 55,456 tons in 1916; in 1920 the exports fell to 34,737 tons, but the high prices realised produced the record value mentioned above. In the early eighties most of the Barbados sugar went to the United Kingdom, and nearly all the rest to Canada and the United States; by 1896 the United States was the importer of nearly all the sugar: a position taken in recent years, for reasons already indicated, by Canada, followed by the United Kingdom, comparatively little going to the United States. In 1920, however, the United Kingdom again became the chief country to which the sugar was shipped. Assistance is given to planters by the Sugar Industry Agricultural Bank, constituted to develop the use of an Imperial grant of £80,000 made to the island in 1902.

A large amount of work in the production, propagation and trial of seedling canes has been carried out by the Barbados Agricultural Department, and manurial experiments with sugar-cane have been made for many years past. In the latter experiments various systems of manuring were tried, and it was found that two applications of sulphate of ammonia, followed by two applications of dried blood, gave the best results; the use of phosphates generally involved a loss, but manuring with potash was shown to be profitable.

The thorough state of cultivation to which the land in Barbados has been brought leaves no room for any significant increase of sugar production in the island.

Canada

Sugar-beet has been grown in most of the provinces of Canada, but its production on a commercial scale is now confined to Ontario.

According to the census of 1911, British Columbia, Saskatchewan, Manitoba, Quebec, New Brunswick, Nova

Scotia and Prince Edward Island together grew 1,260 acres out of a total of 21,937 acres, the remainder being in Ontario and Alberta. It is estimated that the area of beetroots grown in Ontario and Alberta for sugar production was 17,000 acres in 1913 and 12,100 acres in 1914. In the latter year there was an almost total failure of the crop in Alberta owing to drought; the total Canadian crop was estimated at 108,600 tons of sugar-beets, which gives an average yield of about 9 tons per acre, as compared with 8·75 tons in 1913 and 10·5 tons in 1912. In 1915 the area rose to 18,000 acres, but the yield was only 7·75 tons to the acre—a lower yield than in any of the preceding five years; whilst sugar-beet had apparently ceased to be employed in Alberta for sugar production. The area dropped in 1916 to 15,000 acres, with a yield per acre of only 4·75 tons.

Since 1916 the industry has more than recovered its former position, and the area grown and the total yield of both beets and sugar in 1920 constituted a record. The following table shows the position of the industry as regards Ontario and Alberta for the ten years 1911–1920.

—	Area.	Total yield of beet.	Yield per acre.	Total value.	Refined beet sugar produced.
	acres.	tons.	tons.	$.	tons.
1911	20,677	175,000	8·50	1,154,000	9,500
1912	18,900	201,000	10·50	1,005,000	11,900
1913	17,000	148,000	8·75	906,000	11,600
1914	12,100	108,600	9·00	651,000	14,000
1915	18,000	141,000	7·75	775,500	17,600
1916	15,000	71,000	4·75	440,000	7,600
1917	14,000	117,600	8·40	793,800	10,400
1918	18,000	204,000	11·25	2,593,715	22,300
1919	18,800	180,000	9·50	2,630,027	16,900
1920	34,491	343,000	9·94	5,307,243	39,800

The average yields of the root per acre are not so great as those of European beet-growing countries. The seed for beet sowing had to be imported from Germany prior to 1914, but it has now been successfully produced in Ontario. In spite of the increase in recent years the industry is still comparatively small, and large quantities of raw sugar are imported, the quantity in recent years usually exceeding 300,000 tons per annum.

The other sugar-producing industry in Canada, the

making of maple sugar and syrup, realised £370,934 in 1901, and by the end of the next ten years the output had reached a value of £535,476, the share of various provinces being as follows :

Quebec	350,082
Ontario	173,226
New Brunswick	7,779
Nova Scotia	4,122
Alberta, Nova Scotia and Prince Edward Island	267
Total	535,476

The quantity of maple sugar produced varies from year to year, but on the whole there has been an increase in recent years. At the 1910 census Quebec was recorded as producing 8,500 tons, Ontario 3,000 tons and the Maritime Provinces together 200 tons. In 1919 it was estimated that Quebec alone produced 11,500 tons, which at the prices then prevailing would be worth nearly $6,500,000.

The maple sugar produced is used largely for domestic consumption, and there is an export chiefly to the United States, which in 1919 amounted to 2,000 tons, worth over $1,000,000 ; the exports in 1920 were only slightly less. The circumstances of the production of maple sugar preclude the possibility of any rapid extension of the industry.

Egypt

The sugar-cane grown in Egypt is employed both for chewing as green cane and in the manufacture of sugar. The whole of the area under sugar in Lower Egypt and a proportion of that in Upper Egypt is used for the former purpose, the cane grown for the manufacture of sugar being produced in areas in close proximity to the several sugar factories owned or controlled by the Société Générale des Sucreries et la Raffinerie and to the small crude native crushing mills in the same localities. Sugar is not a favoured crop among the fellahin owing to the fact that it requires a great deal of attention and occupies the land for a long time, besides being less remunerative than cotton. It is grown for milling purposes in those lands which are supplied with summer water from the Nile by means of

pumps established on the banks. A great number of these pumps are under the control of the French Company mentioned, who stipulate, as a condition of their furnishing water, that a certain amount of the land shall be planted with sugar-cane which they contract to buy. For purposes of reference a table is given below showing the distribution of sugar planting in Egypt from 1911 to 1919, with an estimate of the amount of cane produced on the basis of 30 tons per acre, which is the approximate average yield. In addition to the weight of cane crushed by the French company, the amount of sugar (white crystalline) and molasses produced each year is given. From the table it will be seen that the French Company uses about half the sugar-cane produced in the country; the remainder is taken by one small modern factory and the numerous native mills which turn out brown coarse sugar and molasses, as well as fine chewing-cane.

Sugar Industry of Egypt

(Compiled from "Annuaire Statistique d'Egypte")

Year.	Area.			Approximate yield of cane.	Quantity of cane manufactured by French Company.	Yield of sugar from cane manufactured by French Company.		Yield of molasses from cane manufactured by French Company.	
	Lower Egypt.	Upper Egypt.	Total.						
	acres.	*acres.*	*acres.*	*metric tons.*	*metric tons.*	*metric tons.*	*per cent.*	*metric tons.*	*per cent.*
1911–12	2,498	49,434	51,932	1,558,000	537,235	54,960	10·22	23,961	4·46
1912–13	2,311	48,003	50,314	1,509,000	741,134	75,420	10·18	37,131	5·01
1913–14	2,377	47,666	50,043	1,501,000	718,055	69,368	9·66	36,908	5·14
1914–15	3,182	50,984	54,166	1,625,000	735,555	75,738	10·31	36,040	4·63
1915–16	4,379	57,098	61,477	1,844,000	970,818	98,964	10·21	44,185	4·55
1916–17	5,066	59,527	64,593	1,938,000	969,611	101,678	10·48	46,670	4·81
1917–18	5,003	60,987	65,990	1,980,000	814,843	79,488	9·75	37,330	4·58
1918–19	4,214	55,096	59,310	1,779,000	796,217	75,899	9·53	41,772	5·24

Exclusive of sugar brought from foreign countries to be refined in Egypt at Hawawdieh, the French Company in 1915–16 produced nearly 100,000 tons of white crystallised sugar of a standard quality. In normal times before the war there had been an annually increasing importation of refined sugar, chiefly from Austria-Hungary and Russia, and an export trade existed in Egyptian sugar with the United States, Turkey, the Red Sea Ports and the Persian Gulf. In 1914 the imports from Europe ceased and Egypt was obliged to use her sugar for local consumption to a

larger extent; nevertheless, in 1914 she was able to export large amounts to England and France, and in 1915 to British Possessions, France and Morocco. Extensive shipping was also carried on between Egypt and India, the sugar exported being largely, if not entirely, that imported from Java and the East as crude sugar and refined in Egypt for re-export. During the period of the war the Egyptian sugar factories had to supply the population of the country and the Expeditionary Force.

The sugar industry in Egypt is of comparatively recent growth, sugar-cane having only been cultivated on a commercial scale since the seventies and in the reign of the Khedive Ismail.

Experiments on the cultivation of sugar-beet were carried out chiefly by the French Company mentioned above and met with no success. The failure was mainly due to the susceptibility of the plants to the attacks of cut-worms (*Agrotis* spp.) and the cotton-worm (*Prodenia litura*), which rendered it impossible to produce a satisfactory crop.

Expansion of the sugar industry in Egypt depends mainly on the extension of perennial irrigation in the upper parts of the Nile Valley. Such irrigation could only be produced by the construction of other storage reservoirs similar to those of Assouan. This district, where the conditions have been found little suited to cotton cultivation, could be used for sugar-cane, but it must be borne in mind that when works have been carried out to give summer water from canals to the growers of sugar-cane who are not dependent on the pumps belonging to the French Company, these growers will certainly grow cotton in preference to cane.

Several kinds of sugar-cane are grown in the country: that known as "Beladi" or country cane has a small sugar content and is not used for milling. "Romui," which probably originated in the West Indies, and several Java and Mauritius canes have been grown for sugar extraction. A certain "Java No. 105" has given very good results, and its cultivation is spreading. This cane is not only the best yet grown in Egypt for cane crop and sugar yield, but is well adapted to the climatic conditions of the country.

British West Africa

Where it exists at all, sugar-cane in the Gold Coast, Sierra Leone, Gambia and Nigeria is only grown for eating; the natives of these countries know little about the use of ordinary sugar, as is shown by the absence of production and the very small imports in proportion to the population. The latter circumstance is of importance when the feasibility of the introduction of sugar production on a large scale into any of these countries is being considered. At the present time, the Gold Coast with its preponderating attention to cocoa, Sierra Leone with its strong exploitation of oil-palm products and kola, and the Gambia with its somewhat small population and restricted facilities for agricultural expansion, are countries where attempts to create a sugar industry would meet with peculiar difficulties. Nigeria, on the other hand, appears to present both in the Northern and Southern Provinces conditions favourable to sugar-cane growing on an important economic scale.

Taking the case of Nigeria, as the country where circumstances appear to be the most encouraging at present, if there were no other conditions but those of natural fitness to be fulfilled, this country could produce a quantity of sugar that would take no inconsiderable place in the world's markets. Irrigation would be necessary for successful sugar-cane growing, except in parts of the Southern Provinces. The provision of labour would form a less serious difficulty in the Northern than the Southern Provinces; it is doubtful if the population of the latter provinces would provide efficient labour for sugar-cane growing and manufacture on a plantation and central factory scale. It is probable that, in the Southern Provinces of Nigeria at least, the best method for the establishment of a successful sugar export industry, without the introduction of indentured labour (a very unlikely event, in any case), would be first to interest the natives in the product so that they might eventually come to make on a large scale a crude sugar, similar to the gur of India, which could be bought by small central factories for refining and shipment.

The cultivation of sugar in Southern Nigeria would

have to be considered in conjunction with other field crops and not alone. There is probably no land in the country which could sustain a crop of sugar-cane upon it for more than two seasons, viz. one ratoon. A scheme of rotation seems to be necessary whereby the land might be planted with sugar-cane for two years and then with yams, cotton and ground nuts, or some leguminous crop, before being again devoted to cane.

Kenya Colony

Sugar-cane is grown to a small extent in this Colony, and there is a small manufacture of crude sugar, or jaggery, by natives of India who have settled in the country. It has been estimated that fully 300,000 acres are available for sugar-cane growing in the Colony; but it is considered that, for an industry on a central factory scale, the labour supply of the country would have to be supplemented by indentured immigration.

Uganda and Nyasaland

Little seems to be known about the possibilities of a sugar industry in these countries. It is certain, however, that the natural conditions existing in some of the lower-lying alluvial areas are suited to the production of sugar-cane in considerable quantities.

NOTES

Machinery for the Palm Oil Industry.—Since the last articles on machinery for the African palm oil industry were published in this BULLETIN (1917, **15**, 57, 270), other machines have been introduced on the market for depericarping the fruits and for cracking the nuts. Four machines were exhibited at the Rubber and Tropical Products Exhibition held at the Agricultural Hall, London, in June 1921.

Two of the new machines are designed for depericarping palm fruits, the other two for cracking the nuts.

Depericarping Machines.—A machine invented by J. O. Drews consists of a horizontal iron cylindrical drum, about 3 feet long and 1½ feet in diameter, with a removable

lid and an outflow lip. To this drum is fitted axially a rotatory shaft with beating arms radiating therefrom about 2 in. apart and in different planes, and to the ends of which are attached rings. Water and palm fruits are placed in the drum and heated by a fire beneath. During the heating, the shaft with the beating arms is rotated by hand, whereby the pericarp is removed from the nuts, and the continued heating and agitation liberates the oil from the pulp. On withdrawing the source of heat and allowing the liquid to settle, the oil rises to the top and the marc or mixture of fibrous pericarp and nuts falls to the bottom. The drum is then revolved sufficiently to allow the oil and the water to escape from the opening provided. The marc is removed from the drum and submitted to pressure in a small hand-press to expel the occluded oil and water.

This machine is in reality more than a depericarper; it prepares palm oil in addition. It will be seen that the process is fundamentally the native method for the preparation of palm oil improved and modernised. The machine has the advantages of being of simple construction, of low cost to manufacture and easily portable, and would no doubt be of value in districts removed from a central factory. Trials are required to show that a single heating is sufficient to free completely the oil from the pericarp. It is understood, however, that a demonstration of the machine has given satisfaction to representatives of one of the largest British firms interested in palm oil.

In contrast with the foregoing machine, the operations of the other depericarper exhibited, Culley's depericarping machine, are confined to simply removing the pericarp from the fruits. This machine consists essentially of a large number of steel discs, which are mounted together on a central shaft to form a revolving cylindrical roller. This roller constitutes the abrading member. A hopper, reciprocating feed and a chamber are fixed above this cylinder, and a wire brush is arranged beneath towards one side. The palm fruits are fed into the hopper, and the machine is set in motion, when the fruits are taken by the reciprocating feed into the chamber, where they are deprived of their pericarp by the action of the abrading roller, the pericarp-free nuts leaving the machine at the end opposite to the hopper, and the pericarp falling below, after being removed from the surface of the discs by means of the wire brush. The pericarp comes away in a dry fibrous condition, but it is essential that it be treated for the expression or extraction of the oil as soon after its removal as possible, in order to avoid an increase in the percentage of the free fatty acids in the oil. Trials carried out with

this machine are said to have given satisfactory results, and it is proposed to put on the market two sizes: (1) a portable hand machine, weighing 56 lb., to be worked by one man, and capable of depericarping ½ cwt. of fruits per hour; and (2) a power-driven machine with an output of 10 cwts. of fruits per hour, and requiring one or two horse-power to drive it.

Nut-cracking Machines.—The "Boby" nut-cracking machine, which is manufactured by Robert Boby, Ltd., of Bury St. Edmunds, incorporates the patent of Tarrant. It has been specially designed for hand power in order to utilise native labour. It consists essentially of a hopper, with an automatic feed and a cracking device with a stationary curved plate, and a rotating roller which is made to approach the fixed member in order to break the nuts. During one revolution of the fly-wheel, the following cycle of operations is performed. The nuts, having been placed in the hopper, are carried round in rows by a revolving drum or feed roll, to which motion is imparted from the main roller axis, the movement both of the roller and drum being intermittent. The nuts, having passed over the feeding drum, fall on to a gate, which is worked by a cam on the main shaft, and which introduces the nuts at the correct moment into the feeding chamber beneath. At the bottom of this feeding chamber is a similar gate which determines the precise moment at which the row of nuts shall fall into the cracking mechanism. Immediately this lower gate has discharged its nuts it closes. The cracking is effected between a curved plate and the roller. The latter is made to move forward or rotate slightly after the feed has been introduced, whereby the nuts are settled in their places. When this is done, the upper half of the cracking plate is made to approach the roller by means of two eccentrics on the main shaft. Owing to the peculiar shape of the space between the cracking plates, the nuts bed themselves down according to their size, the smaller being at the bottom. On completion of the cracking stroke, the lower half of the cracking plate is made to recede from the roller, and the cracked products fall down.

The output of this machine, when being run at fifty revolutions per minute, is stated to be 1,000 nuts per minute and its efficiency is claimed to be 97 per cent. It can be adapted to power-driving, and at the above rate of working requires about one-seventh of a horse-power.

Trials carried out with this machine are said to have shown it to be satisfactory, the kernels being delivered undamaged. It is stated that it is not necessary to grade

the nuts prior to their being cracked, as there is a device fitted to regulate the machine for different sizes of nuts.

The principle of the machine is good, but the nut-cracker as exhibited, which weighed about 10 cwts., is so heavy that it is not easily portable, and would therefore be of more use in a central factory than for transporting from one village to another. It is understood, however, that a lighter model is to be constructed. The cracking device in Drews' nut-cracker is very similar to that in this machine (cf. this BULLETIN, 1917, **15**, 270).

The other nut-cracker under review is marketed by the Vacuum Tool Company, Ltd., of Adelphi, W.C., and must be considered rather as a tool than a machine. The principle embodied in it is quite new for a nut-cracker. This tool consists of a long cylindrical tube about 18 in. long and 1½ in. in diameter, fitted with a piston with handle and furnished at the bottom with a strong iron plate 3 in. in diameter. The nuts to be cracked are placed on a hard surface, such as an iron plate or a flat stone, and the tool held firmly on top of them with one hand. With the other hand the piston is raised, whereby a vacuum is created in the tube. On releasing the piston by removing the hand, the vacuum causes it to resume its normal position, and the impact created thereby on the plate fixed to the bottom of the tool breaks the nuts beneath.

Trials with this tool have shown that it can be used for the purpose intended, but that unless the force of the blow is carefully controlled the kernels are liable to be broken. It has, however, the advantage of being light and easily portable, but it does not seem likely that it will be a serious competitor of the various machines already in use for cracking palm nuts as its output must be of necessity very low in comparison. It is possible that a tool of this type would give better results with larger and harder nuts, such as the cohune.

A modern method for the extraction of palm oil from palm fruits is described in *Les Matières Grasses* (1921, **13**, 5880). The fruits are depulped in a depulping or decorticating machine, which consists of a cage of bars so arranged that narrow spaces are left between them. Inside the cage is a cylinder furnished with a number of steel knives of such size as to leave a gap between the cylinder and the cage in which the fruits are placed. The cylinder is rotated more rapidly than the cage. During the operation of the machine a stream of warm water is passed in, whereby the loosened pulp is carried away through the bars. The water on issuing is re-heated by steam and returned to the cage, its circulation being continued until

it is sufficiently laden with pulp. The liberated pulp is removed from the water by straining, and is then heated, afterwards being pressed in hydraulic presses. The press is fitted with two cages which are used alternately, the charge in one being pressed while the other is being filled. The mixture of oil and water on leaving the press is allowed to settle, and the oil after separation is heated to remove the last traces of water. The nuts from the decorticator are dried, cracked by a centrifugal nut-cracking machine, the shells separated by a brine bath, and the kernels dried. It is claimed that this type of decorticating machine will remove 93 per cent. of the pulp, and that 95 per cent. of the oil in the pulp is extracted.

In the same article is described a machine invented by Paulmier for the preparation of palm oil from the fruits without having to remove the pulp first. The fruits after being slightly heated are pressed, the cake is removed, and the fibrous material separated from the nuts and again pressed. The first pressing gives a yield of 14 to 16 per cent. of oil, and the second 6 to 8 per cent. of oil, calculated on the whole fruits. The machine is stated to be strong, portable, and easy to operate. It may be driven either by hand or by power. Each charge is about 100 lb. of fruits, and a pressure up to 150 kilo. per sq. cm. is exerted.

An outline of the plant required in a modern installation for the preparation of palm oil is detailed (*loc. cit.*). Such a plant consists of decorticating machines, hydraulic presses, nut-cracking machines, conveyors for the fruits to the first-named machines, cooking kettles, filter plant, etc.

Palm Oil as Motor Fuel.—In continuation of the note on the utilisation of palm oil as a motor fuel, which appeared in this BULLETIN (1921, **19**, 379), reference may be made to trials which have been carried out with makes of semi-Diesel engines other than the " Drott " mentioned therein. A 50 h.p. engine, manufactured by Plenty & Son, Ltd., of Newbury, was run on palm oil, after the completion of its tests with gas-oil. No alterations were made to it except the addition of an extra pipe to the filter connected to the tank in which the palm oil was situated. This tank was heated by a burner to liquefy the oil, so that it would flow through the pipe to the cylinder. No trouble was found in running the engine on palm oil, but at 300 revs. per minute the power was reduced from 50 h.p. to 44·1 h.p. This reduction was due to the lower calorific value of palm oil, compared with that of crude petroleum. The fuel consumption was found to be 0·671 lb. per b.h.p. hour. After a run of six hours' duration the piston and cylinder were free from carbonaceous deposit.

Another English firm, Robey & Co., Ltd., of Lincoln, also manufacture a semi-Diesel oil engine which, it is stated, can be driven satisfactorily by palm oil without any structural alteration. This make is not fitted with a water injector to overcome pre-ignition, as the firm are of opinion that this system causes excessive wear.

M. Mathot has carried out a series of experimental trials with various engines of the semi-Diesel type, using palm oil as the fuel. Among these were included a two-cycle and a four-cycle engine, both made by Gardner of Manchester. The results of these trials, which were satisfactory, are published in *Bull. Mat. Grasses* (1921, Nos. 7 and 8, p. 116), together with suggestions for the improvement of this type of engine with a view to increasing its efficiency when palm oil is used as fuel.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the BULLETIN *a summary is given of the contents of the more important papers and reports received during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India and the Tropics generally. It must be understood that the Imperial Institute accepts no responsibility for the opinions expressed in the papers and reports summarised.*

AGRICULTURE

FOODSTUFFS AND FODDERS

Wheat.—Wheat growing has long been the subject of agricultural trials in the Sudan (cf. this BULLETIN, 1911, **9**, 198; and 1914, **12**, 352), but during the last eight years experiments on a more comprehensive scale have been carried out at Shambat, near Khartoum, the climate and soil of which are typical of large areas in Northern Sudan. The records of the trials and recommendations based on the results are given in *Publication No.* 19 (1921), *Chemical Section, Wellcome Tropical Research Labs., Khartoum.* In addition to selection experiments with the indigenous "beladi" wheats, many exotic kinds have been cultivated, but only those from Egypt, India and Australia appear promising. Early maturing varieties alone are suitable, as not only is the wheat season in the Sudan of short duration, but a long period of growth would render the wheat more likely to be attacked by rust, which generally makes its appearance towards the end of the season. Of a large number of varieties originally tried, fifteen were

chosen and grown under observation for five to seven seasons. These consisted of six Australian, five Indian, two Egyptian and two native varieties. The Australian varieties were of strong growth and matured early; the Indian varieties showed a less robust habit of growth, but also matured early, especially that known as "Indian, No. 40"; the Egyptian and native varieties had a longer period of growth than the other kinds. Full details of yields, chemical composition, description of straw and ears, and baking trials are recorded in the publication, and the respective milling values of the wheats are given. With regard to "strength," the best of the varieties were in this respect intermediate between English or Indian varieties on the one hand, and American or Russian on the other. The properties of each variety have been duly considered, and in view of superiority of yield, shortness of growing period, immunity to rust, and good milling qualities, the three varieties, "Federation" (Australian), "Firbank" (Australian) and "Indian No. 40," are recommended for distribution to native cultivators.

Barley.—Samples of barley from various districts in Kenya Colony have been submitted to brewing experts in South Africa in order to ascertain their value for malting purposes. The results, published in *The Farmers' Journ.* (August 18, 1921, p. 8), indicate that on the whole all the barleys, consisting of one "six-rowed" and four "two-rowed" varieties, are good, and suitable for brewing purposes. The cost of transport of Kenya barley to South Africa and England is so great that the cultivation of the crop cannot succeed commercially unless high prices for the grain are maintained in the countries mentioned. No definite recommendation is made as regards exportation, but it is suggested that farmers situated satisfactorily for barley growing should keep the crop in mind as a possible source of revenue, in the event of transport rates falling and the market proving attractive.

Chicory.—The *Journ. Dept. Agric. Union of S. Africa* (1921, **3**, 120) draws attention to the prospects which this crop offers at the present time to South African farmers. Chicory is considered a safe crop, and not nearly so liable to destruction by hail, drought, wet or frost as other farm crops, and hitherto it has not suffered from attacks of insects. A good deep loam is essential, which should be well drained, and if the rainfall is not sufficient, irrigation must be practised. The crop has been grown successfully

without irrigation at Alexandria, Bathurst, Peddie and George in the Cape Province, and at Bethal in the Transvaal; and with irrigation at Pretoria and Piet Retief in the Transvaal, at Gamtoos in the Cape, and in Swaziland. The journal gives a full account of the methods of cultivation, including preparation of the soil, sowing, lifting the roots, drying and roasting. The last two operations may, however, be left to the chicory manufacturer, with whom farmers are recommended to form contracts at the beginning of the season for the purchase of their produce. Farmers now growing chicory in South Africa obtain yields of from 6,000 to 16,000 lb. of fresh roots or 1,500 to 4,000 lb. of dried roots per acre, resulting in a return of from £15 to £45 per acre. The costs of cultivation range from £8 to £15 per acre, leaving therefore, after allowing for interest and overhead charges, a profit of up to £30 per acre, according to circumstances.

Elephant Grass.—The elephant grass of eastern tropical Africa (*Pennisetum typhoideum*) was first grown as a fodder plant in Rhodesia in 1909, under the name of "Napier's fodder," and has given good results in that country (cf. this BULLETIN, 1914, **12**, 127). It has since been introduced into other parts of the world, including Australia, Florida and the Philippines. The *Agric. Gaz., N.S. Wales* (1921, **32**, 483), contains a general account of the grass and its cultivation, and also a summary of the results obtained by the Department of Agriculture and by over one hundred farmers who have grown it in different parts of the State. The grass has shown itself adapted to the coast, tablelands and slopes, and in the far western districts of New South Wales it does well under irrigation; it cannot endure the hot winds and the extremely hot surface of the red soil plains in the summer months. In the coastal regions it produces a greater yield of fodder than any other plant. Trials have been carried out on the feeding of elephant grass to cows, and the milk and butter-fat records show that the yield and quality of the milk are maintained when this grass is substituted for natural pasture.

The composition of elephant grass at various stages of growth in comparison with better known grasses and feeding stuffs is given in *Queensland Agric. Journ.* (1921, **16**, 6). The analyses show that only very young elephant grass can be classed as a fodder of fair quality, and that this has only about half the value of couch grasses or of prairie grass as a food for cows. As the grass grows older, the food value rapidly declines, and becomes very low when

maturity is reached. The protein content of the grass is low, and inferior to that of sorghum and sugar-cane tops, but about equal to that of maize stalks.

In the Philippines, where the grass was introduced in 1918, it has shown itself well adapted to the climate and soil, and to be more drought resistant and greatly superior to other forage plants now grown in the Archipelago, including guinea grass, Para grass, and Japanese forage cane (*Philippine Agric. Rev.*, 1920, **13**, 353).

Lespedeza.—The general cultivation and use of this legume as a pasture and hay crop is described in *Farmers' Bulletin*, No. 1143 (1920), *U.S. Dept. Agric.* (see this BULLETIN, 1920, **18**, 556). A further account of the plant is given in *Bulletin* No. 123 (1921), *Univ. Tennessee Agric. Exper. Station*, which describes three new varieties selected and propagated at the station. These varieties are stated to be superior in yield and habit to the mixture which is usually grown, and one of them is well adapted for hay, one for pasture, and one for growing in those sections of the State where the season is short. Manurial experiments showed that while the addition of potash, phosphates or nitrate of soda to the " thin grey land " of the West Tennessee Station had no appreciable influence on the yield of hay, the addition of lime had a marked beneficial effect.

OILS AND OIL SEEDS

Babassu Nuts.—A machine for cracking babassu nuts is the subject of English patent, No. 29,668 of 1919, by Moon and Adams. The nuts are opened by exerting pressure by means of blunt bevelled-edged tools at right angles to the longitudinal axis, whereby the nuts are distorted and burst. The tools are arranged opposite one another, one being fixed and the other being able to move backwards and forwards by means of a reciprocating rod. These tools are bevelled and curved, so that the points first enter the shell and assist in bursting the nut. A device is fitted to the machine so that when the nut bursts the movable tool does not, on being jerked forward, penetrate the kernels.

Beech Nuts.—The nuts of the common beech tree (*Fagus sylvatica*) are very often wasted by being allowed to rot under the trees, in spite of the fact that they might be profitably employed as an oil seed (*Les Matières Grasses*, 1921, **13**, 5860). It is stated that one hectare of beech trees should yield about half a ton of oil. The nuts contain from

15 to 20 per cent. of oil. They can be decorticated and the thin seed-coat afterwards rubbed off by shaking the kernels in a sack. If the kernels are ground, water added, and the meats pressed in the cold, a yield of from 14 to 16 per cent. of oil is obtained, whilst a further 3 to 4 per cent. of oil is secured by hot pressing. The cold-pressed oil is clear, yellow and viscous, with a sweet taste, while the hot-pressed oil has a slightly bitter taste, which can be removed by boiling the oil with water, in which the bitter principle is soluble. The better qualities of this oil are edible, while other grades can be used as an illuminant and for soap manufacture. The residual press-cake from the decorticated seed is rich in protein, and is recommended as a feeding stuff for cattle. The undecorticated cake is harmful to animals, and can therefore only be employed as a manure.

Candle Nuts.—The results of a chemical investigation of candle-nut oil (*Aleurites moluccana*) are published in the *Phil. Journ. Science* (1921, **18**, 619). The tree grows abundantly in the Philippine Islands in the wild state, and is also cultivated. The authors, West and Montes, found that the oil is composed of the glycerides of the following fatty acids: linolenic, 6·5 per cent.; linolic, 33·4 per cent.; oleic, 56·9 per cent., and solid acids, 2·8 per cent. In chemical composition, candle-nut oil resembles linseed oil rather than tung oil.

Japan Tallow.—France imports annually from Japan considerable quantities of Japan tallow, derived from the fruits of *Rhus succedanea*. The tree occurs, among other places, in Indo-China, especially around Tonkin, and in Madagascar. Samples of the fruits from these two countries have recently been examined, when the kernels were found to yield from 31 to 34 per cent. of fat, and the mesocarp 28·9 per cent. The results of the chemical examination of the fat from the mesocarp show that the fruits of *R. succedanea* from Indo-China furnish a product of similar nature to Japan tallow of commerce. Enquiries are being made with a view to the economic utilisation of these fruits, which at present are not used by the natives of Indo-China (*Bull. Econ. Madagascar*, 1921, **18**, 215).

Palm Oil.—According to *Bulletin Mat. Grasses*, Nos. 3 and 4, 1921, p. 45, not a quarter of the palm trees in the Lahou district, Ivory Coast, are exploited. The fruits from most of the palms are lost through not being collected, or through careless storage after being gathered. The yield also

suffers through the trees being tapped for palm wine. On the other hand it is stated that the native population is not large enough to effect the collection of the whole of a year's crop. A list is given of the various regions where plantations of oil-palms are to be found, and of places in the Lahou district of the Ivory Coast which are considered suitable for the erection of factories.

A further contribution to the study of the oil-palm in the Belgian Congo is published in *Bull. Agric. Congo Belge* (1921, **12**, 305). In this study are described the oil-palms growing in the districts of Ubangi and Doruma, and at the Experimental Stations of Ganda-Sundi (Lower Congo) and of Gazi (Stanleyville). Details are given of the number of trees, their density, age and productivity, together with the names of the principal varieties. Short accounts are included of the cultivation of the palms, the uses of the various products and of the commercial possibilities. The method of preparation of palm oil at the Gazi Experimental Station, in which the oil is obtained by pressing the heated pulp, is described. Among the insect pests found attacking the palms at this station are the *Rhyncophorus* and *Oryctes* beetles, and another insect probably a *Xylotrupes*. Of these the first-named is by far the most harmful (see this BULLETIN, 1920, **18**, 239).

A general article on the African oil-palm with special reference to its cultivation in Malaya as an alternative to rubber and coconuts is given in the *Planter* (1921, **1**, Nos. 9–12; 1921, **2**, No. 1). Experimental trials have shown that oil-palms grown in the Federated Malay States give better results than those grown in Sumatra. Several syndicates were formed about 1919 to develop the cultivation of the oil-palm in Malaya, but a reaction set in in the middle of 1920, with the result that progress was suspended. It is considered that this country would be more suitable for the oil-palm than for the coconut, as the former will flourish in inland districts where the latter will not. The rich rolling lands of many parts of Malaya are well suited to the successful and profitable development of the African oil-palm. As regards rainfall, Malaya compares quite favourably with the oil-palm region of West Africa.

Waxes.—Three waxes from the desert region of the south of Madagascar are described in *Les Matières Grasses* (1921, **13**, 5871). These waxes occur on the branches of *Vohemaria Messeri* (= *Cynanchum Messeri*), *Euphorbia xylophylloides* and *E. stenoclada*. The wax is prepared either by cutting up the branches into pieces, drying and beating them, the dust then being thrown into boiling

water and the scum collected, or by soaking the branches in boiling water and collecting the scum. Of the two methods, the former is the better, although longer. On the average, an *E. xylophylloides* tree yields about 1,800 grams of wax by the first process, *E. stenoclada* a little less, and *V. Messeri* slightly more. The three waxes are brown and friable, and are similar to one another and to vegetable waxes in general as regards their chemical composition.

Rubber

Hevea brasiliensis

Grenada.—According to the *Rept. Agric. Dept., Grenada*, 1920, p. 20, estates which were established in the island during 1906–7 now possess several thousand rubber trees. Following experiments in the Botanic Gardens, two estates out of three visited were advised to commence tapping. During the three and a half months ending September 30, 1920, 1,343 trees were tapped on alternate days, and yielded 386 lb. of dry biscuit rubber and 103 lb. of scrap rubber. The owners ceased tapping in October on account of the low market price of rubber.

Tapping.—*Archief voor de Rubbercultuur* (1921, **5**, 111) gives an account of investigations into the origin of latex, based on the principle that the appearance of white latex where yellow latex previously existed indicates that these places are exhausted and that secondary latex building is taking place. The investigations show that the flow of latex to the tapping cut is very slow. After two and a half months it covers a distance of 1 metre. When using the ordinary method of tapping downwards, the latex is only extracted from latex vessels immediately under the tapping cut and in the cortex within 5 cms. of the tapped area. If the tapping cut is high above the ground, the latex comes from the trunk only. If the tapping cut is low down, latex is also extracted from the roots. The tests were made with three-year-old, grafted trees, in the trunk of which was yellow latex, while the stock contained white latex.

Preparation.—In the same issue of the *Archief* (p. 128) it is shown that brackish water (for instance tidal river water) when used for diluting latex has a harmful influence on the properties of the rubber, owing to the retention of small quantities of salts. The evil effects of sea water show themselves in lower tensile strength of the vulcanised

product, longer vulcanisation time, longer drying time, and lower viscosity. When less than 12 per cent. of sea water is mixed with fresh water, the evil effect of sea water is not noticeable in sheet rubber. When the rubber is converted into crêpe, it requires 28 per cent. of sea water to cause a definite deterioration in the properties of the rubber.

Archief voor de Rubbercultuur (1921, **5**, 219) gives an account of investigations carried out in Java of the Ilcken-Down process of rubber preparation. The method consists in: (*a*) Coagulation of latex in the absence of air in a specially constructed wooden tank by the addition of a mixture consisting approximately of alcohol 53 parts and fusel oil 34 parts. (*b*) On the following morning is added a mixture of alcohol 2 parts and petrol 1 part. (*c*) The freshly rolled crêpe is treated with a dilute solution of sodium bisulphite and sulphuric acid.

The patentees claim that their process gives an increase in weight of from 5 to 15 per cent. It is stated that the first mixture preserves the enzymes which form rubber in the latex, whilst the second mixture hardens the coagulum and precipitates some rubber together with proteins from the serum. The bisulphite-sulphuric acid bath is said to keep the colour of the crêpe pale and even.

At the end of 1919, Mr. St. V. Down, one of the patentees, went to Java and made a series of experiments in collaboration with the scientific officers of the Central Rubber Station. Experiments were made on three different occasions, once during the rainy monsoon at an elevation of 1,800 feet, once during the dry monsoon on a low lying estate, and finally in the experimental garden at Buitenzorg, choosing bright and sunny days after rainless nights with a shorter interval between tapping and coagulation. The alleged increase in weight was not found in any case, thus confirming the results obtained in Malaya by Eaton (*Agric. Bull. F.M.S.*, No. 27, 1918, p. 275).

The properties of the Ilcken-Down rubber were found to be normal and approximately the same as the control. The time of vulcanisation was somewhat longer. Experiments on the keeping properties of the rubber are not yet finished. A first series of determinations did not show any important deterioration in the course of a year.

Keeping Properties of Plantation Rubber.—In *Archief voor de Rubbercultuur* (1921, **5**, 100) it is shown that little change takes place in first-quality plantation rubber on keeping for two years packed in chests in the tropics. The only alterations detected were in the viscosity of the

solutions prepared from the rubber and a small change in the time required for the vulcanisation. In addition, pale crêpe darkened decidedly, while smoked sheet lost its brightness. Some of the samples of lower grade rubber showed a distinct deterioration, especially such types as washings, bark and earth rubber.

Brown Bast.—A series of important papers on the brown bast disease of *Hevea brasiliensis* has recently been published. Rands, in *Med. van het Instituut voor Plantenziekten*, No. 47, *Dept. van Landbouw, Nijverheid en Handel* (reprinted from *Archief voor de Rubbercultuur*, 1921, **5**, 223), gives a detailed account of the results of his work on the subject in Java and Sumatra, concerning which preliminary reports have already been published. As regards the history of the disease, the author adduces evidence in support of the view that, although brown bast has come into prominence only in recent years, the disease has probably existed in the East for a much longer period. Its relative abundance in the past few years is attributed to a number of factors, the most important being excessive tapping. A detailed account is given of the unsuccessful attempts made by various investigators (including the author himself) to isolate a causal organism associated with brown bast, and of the failure to inoculate healthy trees with diseased tissue. On the other hand, in many cases it was found possible to cause the disease to appear in healthy trees by severe over-tapping. The author concludes that brown bast is a physiological disease, and may be regarded as an extreme type of wound response; it is a form of "gummosis." The repeated withdrawal of latex from the same tissues is considered to be the chief factor concerned, though the time interval between the tappings, and the system of tapping, would appear to be of more importance than the actual quantity of latex extracted. The extent of the disease is said to be influenced indirectly by environmental factors. In general, the most vigorous trees and those with the highest yield are the first to become affected, and the disease is more frequent during the rainy season, which also is the period of high latex production. In this connection it is interesting to note that a proposed method of treatment by thinning the plantations may actually result in an increase of the disease, since this operation commonly results in enhanced vigour of the trees and greater yield of latex. As regards treatment, the author describes the well-known methods now adopted in the East, which have as their object the removal of the diseased tissue, either

by "scraping" away the brown bast or by "stripping" the affected bark down to the cambium, with subsequent employment of measures to prevent the desiccation or other injury of the delicate exposed tissue. The "tar method" of Harmsen in which the scraped bark is dressed with warm tar is also mentioned.

In a second paper (*Med. van het Instituut voor Plantenziekten*, No. 49, *Dept. van Landbouw, Nijverheid en Handel*) Rands gives a detailed technical account of his microscopic studies of brown bast. A considerable part of the paper (which is illustrated with excellent photographs and diagrams) is concerned with an account of the methods employed in the investigation, and with a suggestive review of the literature of wound gum. Briefly, the author finds that the discoloration and cessation of latex flow characteristic of the disease are caused by the deposition of a yellowish gum-like substance in the bark tissues, which fills the intercellular spaces and clogs the latex-vessels, as well as staining the cell membranes concerned. The gum appears to be secreted by the parenchyma cells adjacent to the latex-vessels and intercellular spaces, and does not arise by the breaking down of the cell-walls. Apart from the question of gum secretion, the latex itself is usually found to be coagulated in the affected vessels. A marked similarity was observed between brown bast and the discoloured tissue formed at the borders of ordinary wounds in Hevea bark, and comparative studies of this local wound reaction and brown bast showed that they appear to be closely related phenomena. According to Rands, the evidence indicates that brown bast may be regarded as an abnormal and extreme type of wound gum secretion, probably resulting from the response on the part of the tree to excessive tapping.

Sanderson and Sutcliffe in their book, *Brown Bast* (see this BULLETIN, 1921, **19**, 433), consider the disease to be physiological in character and brought about as a result of over-tapping. They differ, however, from Rands in their account of the anatomical symptoms of the disease. According to these authors (working in Malaya), the constant and characteristic anatomical feature of brown bast is an abundant meristematic activity in the parenchymatous tissue of the bark, while secondary symptoms include the deposition of "tannins" and crystals of calcium oxalate, the occurrence of oily globules, and an unusual development of stone-cells. The meristem occurs in the immediate neighbourhood of the latex-vessels, which become ruptured, the latex exuding into the intercellular spaces, where it coagulates. The latex in part also coagu-

lates in the vessels themselves, as noted by Rands and others.

Farmer and Horne (*India-rubber Journal*, 1921, **61**, 1225) and Horne (*Annals of Botany*, 1921, **35**, 457) throw new light on the anatomical question. These authors investigated, in London, diseased bark from Malaya and British North Borneo, and confined their attention to early stages of the disease. The affected bark in transverse sections showed irregular, golden-yellow spots in the phloem which sometimes appeared to resemble distorted intercellular spaces. Careful examination, however, showed that the yellow areas were in fact sections of necrotic sieve-tubes. In young phloem the disease was confined to the sieve-tubes, but in older tissue latex-vessels, medullary-ray cells and phloem parenchyma were also found to be disorganised; while, commonly, the diseased area was found to be more or less enveloped by meristematic tissue. These observations therefore emphasise the significance of the fact that, in tapping, essential elements other than latex-vessels, viz. the sieve-tubes, are wounded and their functions suspended. Investigations on the spot, with a view to checking these observations, will be watched with much interest.

Gandrup (*Med. van het Besoekisch Proefstation, Rubber-serie*, No. 19, 1921, reprinted from the *Archief voor de Rubbercultuur*, 1921, **5**, 465) has carried out an interesting investigation on the origin of the stone-cells occurring in Hevea bark tissue. In young plants the stone-cells arise among the thick-walled pericycle fibres, which later become almost entirely replaced as such by the development of a ring of stone-cells.

FIBRES

Flax.—Notes on the establishment and development of the flax-growing industry of Kenya Colony have been published in previous numbers of this BULLETIN (1914, **12**, 211; 1917, **15**, 123; 1919, **17**, 129; and this volume, p. 62). Further information on the subject has appeared recently as *Bulletin* No. 9 (1921), *Dept. Agric., Colony and Protectorate of Kenya*, entitled "The Growing and Harvesting of Flax in Kenya," by W. G. Scott and G. M. Hamilton, Flax Officers. This publication contains notes for intending planters on the selection of the district and soil, the preparation of the land, seed and varieties, sowing, weeding, harvesting, stacking, de-seeding, and straw-cleaning, and reference is made to the work carried out at the Government Farm, Kabete. The following

varieties were tested at this farm during 1920, and the results are recorded: English Dutch Child; Japanese; Canadian Ontario; Canadian Western (from Japanese seed grown once in Western Canada); and Dutch Child (third year, Kabete). The seed was imported in all cases except the last, and in this case it was produced from the progeny of Dutch seed sown for three successive years in Kenya. The behaviour of these varieties on a commercial scale would doubtless vary with different districts and soils, but, in general, the Dutch Child (third year, Kabete) proved the best in the trials, and gave a good yield of fibre of excellent quality. The following provisional conclusions have been drawn from the results of the work hitherto accomplished: (1) Dew retting is superior to water retting, as it generally gives a higher yield of flax of greater value, and a more valuable tow. (2) That for the production of large yields of fibre and seed, the rainfall during the period of growth is of the utmost importance. (3) That at the present market prices, the gross return per acre is sufficient to render the crop remunerative.

New Zealand Hemp (*Phormium tenax*).—An account of the present position of the Phormium fibre industry of St. Helena is given in *Colonial Reports, Annual*, No. 1084, *St. Helena*, 1920. During 1920, the Government mill produced 95 tons of fibre and 55 tons of tow, whilst three private mills together produced 347 tons of fibre and 230 tons of tow, the total output thus amounting to 442 tons of fibre and 285 tons of tow. The exports of fibre and tow during the year were 838 tons of value £38,795, as compared with 603 tons of value £27,108 in 1919. In addition, 117 coils of St. Helena rope were exported, valued at £391. The average prices obtained in the London market during 1920 were £54 15*s*. per ton for fibre and £36 15*s*. per ton for tow.

Sisal Hemp.—In earlier numbers of this BULLETIN (1913, **11**, 141; 1915, **13**, 122, 433) information has been given on the Sisal hemp industry of German East Africa (now known as Tanganyika Territory). Reference to the position of this industry during recent years is made in the official *Report on Tanganyika Territory from the Conclusion of the Armistice to the End of* 1920 (Cmd. 1428, 1921). It is stated that during the period under review the industry was severely hampered for some considerable time by the lack of shipping. The quantities of fibre exported during the period of three years ending March 31, 1920, were as follows: 1917–18, 3,344 tons; 1918–19, 7,954 tons; 1919–20,

16,744 tons; total for the three years, 28,042 tons. At the close of that period about 1,000 tons were awaiting shipment. The output of Sisal hemp has since been restricted by the curtailment of the development of the plantations and the decrease in the market prices for the product.

In comparison with the above figures, it is of interest that the exports of the fibre in 1913 amounted to 20,835 tons.

Cotton

Linters.—An interesting account of the characters, production and uses of linters is given by A. M. Agelasto, Specialist in Cotton Classing, in *Department Circular* 175 (1921), *U.S. Dept. Agric.* Linters consist of the fuzz of the cotton seed together with such of the ordinary cotton fibre as has escaped removal during ginning. The process of removing the linters is known as delinting or "cutting," and is usually carried out in the oil mills. Delinting was formerly effected by a modification of the saw gin with suitable condensers attached, which deliver the linters in the form of bats or rolls, and in quantity ranging from 25 to 75 lb. per ton of seed. During the war linters were in great demand for the manufacture of explosives, and new systems of delinting were introduced, which cut the fuzz more closely and yielded as much as 140 to 200 lb. of linters per ton of seed. One of these new systems depends on the use of rapidly revolving discs or wheels coated with carborundum cloth or paper (similar to emery paper), which literally polishes the fuzz from the seed. Another system, known as the suction system, blows the fibre from all the different delinting machines, mixes it, and condenses it into one uniform grade; the resulting product in this case, however, is not obtained in the form of a bat or felt, preferred by mattress makers and others, and is, therefore, of no use, except for explosives. After January 1919 the demand for linters for explosives came to an end, and the mills gave up the suction system, and again produced a "mattress lint" at the rate of about 65 lb. per ton of seed. The oil mills had, however, learned the value of the suction system in saving labour and giving a cleaner and more uniform product, and a method has now been devised by which the linters from the various machines are mixed and condensed in the form of felt. Cotton seed is not only delinted for the sake of obtaining linters, but, in some cases, for the purpose of procuring clean seed for sowing which germinates more quickly than seed with the fuzz on it.

Statistics of the production of linters in the United States are given for the years 1899–1900 to 1919–20. The output amounted to 556,000 bales or 3½ per cent. of the cotton crop in 1911–12, and increased to 1,331,000 bales or 10·9 per cent. of the cotton crop in 1917–18; in 1918–1919 it fell to 7·7 per cent., and in 1919–20 to 5·4 per cent. of the cotton crop.

Linters are used for many purposes, including the stuffing of mattresses, cushions, etc., the manufacture of absorbent cotton, felt, and low-grade yarns for wicks, twine, rope and carpets, and as cellulose for making artificial silk, paper and explosives. The processes to which the fibre is subjected in preparing it for use in the manufacture of gun-cotton are described.

The cessation of the demand for linters for explosives has led to over-production, and new uses for the material are needed. It is anticipated that in the future the paper-making industry will afford an outlet for large quantities, and it is hoped that other commercial uses will be developed.

Tanganyika Territory.—An account of the cotton industry established during the German occupation of Tanganyika Territory has been given in this BULLETIN (1915, **13**, 114, 124). In earlier issues (1913, **11**, 468, and 1914, **12**, 611) information was published regarding (1) the work of the cotton experiment stations in the Territory, and (2) the various insects which are prevalent and may attack the cotton plants.

Further particulars of the industry have recently been given in the official *Report on Tanganyika Territory from the Conclusion of the Armistice to the End of* 1920 (Cmd. 1428, 1921). It is pointed out that the initiation of the industry was due to the German Colonial Economic Committee and the German Government. The natives were encouraged, and in some cases forced, to plant; seed was distributed, instruction was given by itinerant teachers, and text-books in the vernacular were provided. Facilities were afforded for European planters to purchase machinery at manufacturers' prices; freights were regulated, and space secured for them; and the German Government not only framed special legislation designed to maintain the quality of the cotton, but even arranged with a Bremen firm for the supply of information to district officers regarding the requirements of the European market.

In 1913 the exports of cotton amounted to 2,192 tons, whilst during the British occupation they were as follows: 1917–18, 910 tons; 1918–19, 752 tons; 1919–20, 741 tons.

These latter exports consisted mainly of enemy stock, which was sold locally.

An effort is now being made to encourage the cultivation of cotton by the natives, and 100 tons of seed have been imported from Uganda for free distribution.

According to the *Report of the Department of Overseas Trade on the Trade and Commercial Possibilities of East Africa* (1921), a distinct increase in cotton growing took place last season in the Muanza District of Tanganyika Territory, and it was anticipated that 800 tons of seed-cotton would be produced in that area.

India.—An article on "Cotton Bollworms in India," by T. Bainbrigge Fletcher, Imperial Entomologist, and C. S. Misra, First Assistant to the Imperial Entomologist, has appeared as *Bulletin* No. 105 (1921), *Agricultural Research Institute, Pusa.* The Indian cotton bollworms include two Noctuid moths, *Earias fabia* and *E. insulana*, and the "pink bollworm," *Gelechia* (*Platyedra*) *gossypiella.* Observations have been made at Pusa for many years past regarding these three moths, and the results are now recorded. It is estimated that the damage caused annually to the cotton crop of India by these insects amounts in normal years to something between 20,000,000 and 50,000,000 rupees. It appears that *Earias insulana* is the predominant bollworm in the Punjab and Bombay; *E. fabia* in Bihar and Orissa, Bengal, Madras and the Central Provinces, and *Gelechia gossypiella* in the United Provinces and the North-West Frontier Province. The work at Pusa has established the fact that the pink bollworm is not so susceptible to the attack of parasites as are *Earias fabia* and *E. insulana*, although a Microbracon (*M. lefroyi*) has been found as a parasite on pink bollworms, both in cotton and their alternative food-plant, *Hibiscus abelmoschus*. In 1918 a Bethylid parasite was found on pink bollworms in cotton seed obtained from cotton seed stores at Nawabganj, Cawnpore, and a Braconid has recently been obtained at Coimbatore, which is apparently parasitic on these insects. At Pusa, however, it has not been possible to obtain any Bethylid or Chalcidid parasite, either on the eggs, worms or pupæ of the pink bollworm.

It has been found that attacks of the bollworms could be greatly reduced if, on thinning out the cotton plants when they have reached 12–18 inches in height, as is done in all the important cotton growing tracts of India, the cultivators would pull out first such plants as show signs of withering. In addition to this simple measure, para-

sites should be introduced. In order to act as a complete check to the bollworms, it is necessary that the parasites should breed rapidly and lay large numbers of eggs, but unfortunately none of the bollworm parasites now known fulfils these conditions. *Microbracon lefroyi* is the most active of the bollworm parasites hitherto discovered, but is only effective as a check to a limited extent.

"A Brief History of Experimental Cotton Cultivation in the Plains of Bengal," by G. Evans, M.A., C.I.E., Director of Agriculture, Bengal, has appeared as *Bulletin* No. 1 (1921), *Dept. Agric., Bengal.* It is pointed out that the Province of Bengal grows less cotton in relation to its area than any other Province in India. The following statistics for 1919–1920 and 1920–21 show that the crop is of relatively small importance.

Season.	Early cotton.		Late cotton.		Total.	
	Acres.	*Bales.*	*Acres.*	*Bales.*	*Acres.*	*Bales.*
1919–20	66,693	23,613	2,159	999	68,852	24,612
1920–21	68,435	19,978	1,707	892	70,142	20,870

The early cotton, grown in the Chittagong Hill Tracts, is classed in trade as "Comilla," and consists of very short harsh cotton, used chiefly for mixing with wool or for stuffing mattresses, etc. The late cotton is cultivated in scattered areas over the more elevated parts of Bankura and Midnapore in Western Bengal. It has a short staple, but is of finer quality than the early cotton, and is graded in commerce as Bengal-Sind, a name which is very misleading, as most of the cotton included in this class is not grown in Bengal, and apparently was never produced in any large quantity in the regions now comprised in the Bengal Province.

The historical sketch of the industry which is given indicates that during the last century a great amount of time and money has been expended with the object of introducing cotton into Bengal as a field crop, and that varieties of cotton have been tried which emanated not only from all parts of India, but from nearly every cotton-growing country in the world. In spite of all these efforts, however, no useful result has been achieved, and the cultivators prefer to grow jute and rice, as these crops are more profitable. Moreover, the climatic conditions of the greater part of Bengal are quite unsuitable for cotton. The average rainfall is about 80 inches, and the soils become badly water-logged, owing to lack of natural drainage, and

there is, therefore, no possibility of cotton being successfully grown as a monsoon crop.

It is considered that the only chance of establishing cotton in the field on an extensive scale is to grow it in certain parts of the Province as a cold weather crop. The temperature in Lower Bengal never falls so low as to injure the plant, and the bolls would be formed during February and March, which would lessen the danger of attack by insect pests. Light irrigation might be necessary if the winter showers should fail, and, in this case, the water could be easily obtained from wells.

Experiments are to be made on these lines, and it is desired to obtain for the purpose some of the original famous Dacca cotton which was referred to in 1788 as "the finest cotton in the world, and producing cotton of astonishing beauty and fineness." A careful search is being made for this variety in the Dacca Division, but it is feared that it may now be extinct. A few plants may perhaps be found, however, in obscure parts of the Madhupur jungle.

West Indies.—In the *Rep. Dept. Agric., Barbados, for* 1920–21, further reference is made to the experiments which are being carried out with the object of effecting an improvement in the locally grown varieties of Sea Island cotton (cp. this BULLETIN, 1921, **19**, 226). A specially selected strain of Sea Island cotton has now been obtained, which is practically immune to leaf blister mite, and to a great extent free from the usual insect and fungoid pests, with the exception of the cotton caterpillar. The native variety mentioned in the previous report (*loc. cit.*) also continues to improve under the system of cultivation and selection practised, and is free from all pests and diseases, except the cotton caterpillar.

The recent introduction of the pink bollworm (*Gelechia gossypiella*) into the West Indies is recognised as a source of danger to Barbados, and every effort is being made to prevent its entry into the island, no cotton seed being permitted to come in from infected regions or even from non-infected territory adjoining an infected region.

The area devoted to cotton in Barbados in the year 1919–20 was 1,179 acres, as compared with 1,445 acres in the previous year. The exports in 1919–20 amounted to 100,610 lb. of cotton of value £13,201, and 4,174 lb. of linters of estimated value £97 15*s*. 6*d*. There were also produced 247,921 lb. of seed of the estimated value of £921, all of which, with the exception of that used for planting, was employed locally for the manufacture of oil and

undecorticated cotton-seed meal. The yield of lint per acre was 85 lb., as against 79 lb. for the year 1918–19. In the latter year, 114,444 lb. of cotton were produced of the estimated value of £22,888.

FORESTRY AND FOREST PRODUCTS

Native Timbers of South Africa.—Within the Union of South Africa there are stated to be 800,000 acres (1,250 sq. miles) of forest and plantation, 550,000 acres being indigenous high forest, and 250,000 acres plantation. This is about 0·25 per cent. of the total area of the Union. From this area 450 species of trees are briefly described in the alphabetical order of their botanical names in a memoir by Dr. T. R. Sim, published by the Department of Mines and Industries (*Memoir No.* 3, 1921). The native names are added and fully indexed with indications of the districts in which the species occur, and the habit of some forty trees is illustrated by photographs, together with photographs of the pods of a score of species of *Acacia*; but no adequate means of identifying the other trees is furnished. Tables of the mechanical properties of Cape timbers tested by Professor Unwin for the Imperial Institute, and of Natal timbers by H. G. Fourcade, are reprinted, and a considerable amount of information is given as to the woods suitable for various purposes, their immunity from termite attack, etc. Yellow-wood has formed 8·12 per cent. of the number of trees and 48·3 per cent. of the total volume of timber cut in the Crown forests (nearly four-fifths of the whole) between 1911 and 1916.

Teak in Togo.—In 1911, Dr. A. H. Unwin, then Conservator of Forests in Southern Nigeria, visited Togo, and at the beginning of the following year reported on the afforestation of the country with teak and native timber trees, showing upwards of a million trees planted on 878 acres (cf. this BULLETIN, 1913, **11**, 169). A later report of a visit by M. Houard, an official from the French Sudan, in 1917, has now appeared (*Bull. Hist. et Scient. de L'Afrique Occid. Française*, 1921, pp. 8–44). The first teak seed was imported by the Germans in 1901; but as teak has the advantage of bearing fruit from its third year, its area was rapidly extended and it proved very adaptable to differences of soil and climate. The rate of growth diminishes and the quality of the wood increases from south to north; and though the yield in the northern zone of the country is distinctly inferior, land of low value can be utilised. There

is no return until the first thinning in the fifteenth year; it is estimated that the expenditure entailed till then amounts to 3,350 francs per hectare in the south, and 3,050 francs in the north, whilst that from the sixteenth to the thirty-fifth year is covered by the profit from the thinnings. Teak is, therefore, a more costly crop to start than cocoa, coffee or oil-palm, and in colonies which are not suitable for permanent settlers will not appeal to the private owner, though it may ultimately afford a profit to companies, equivalent to 5 per cent. M. Houard, however, recommends teak for Governmental re-afforestation, especially with a view to the regularisation of the water supply.

Indian Timbers.—Continuing their series of accounts of the less well-known timbers of India, the Forest Department have issued three *Forest Bulletins* (Nos. 42, 43 and 44) dealing respectively with Haldu (*Adina cordifolia*, Hook f.), *Odina Wodier*, Roxb., and Semal or Cotton Wood (*Bombax malabaricum*, D.C.). All three monographs are by C. E. C. Cox, Deputy Conservator of Forests in the Central Provinces, and each of them contains a mounted specimen of the wood described, together with a full list of its native names, and a description of its distribution, general characters, habitat, methods of reproduction, timber, uses, minor products and commercial output from each province.

The Forest Industry in Soviet Russia in 1920.—The shortage of workmen, horses and fodder, and the requisitioning of food and tools in the first years of the war, brought about a decline in the forest industry of northern Russia (*Commerce Reports*, U.S.A., No. 180, 1921), which was accelerated by the revolution of 1917, after which felling came to a standstill. The loss of the supplies of Donats coal and Baku oil caused firewood to constitute 88 per cent. of the total fuel consumption in 1918, as against 45 per cent. in 1916, building timber being used for this purpose. In 1920 the Government built thirty-nine electrical saw-mills; but, though the home demand for 1920–21 was 400,000,000 cubic feet and the production programme demanded a minimum of 230,000,000, the Government doubted their ability to saw more than 150,000,000. It is stated that the Russian trade delegation in London concluded a number of large contracts for the supply of Russian timber, the carrying out of which would seriously depress Russian home industries demanding labour, tools and fuel, but that any large exportation of timber from Russia is for some time improbable.

MINERALS

Aluminium

India.—In the quinquennial review of the mineral production of India for the years 1914 to 1918 (*Rec. Geol. Survey, India*, 1921, **52**, 254), H. H. Hayden discusses the prospects of an aluminium industry for India, and states that during recent years increasing attention has been given to the subject of aluminium manufacture in that country, and various tentative schemes have been put forward. Had it not been for the war, some of these schemes might have materialised. The chief difficulty at present is the lack of cheap hydro-electric power. It is hoped that when the large reservoir now being constructed in the Western Ghats is completed, this difficulty may be removed. In the matter of power production, sufficient attention does not seem to have been paid to the Himalayan rivers: this is no doubt due to the supposed absence of bauxites in those regions. Recently, however, large deposits have been discovered by C. S. Middlemiss in the Sangarmarg and adjacent coal-fields of the Jammu Province. There is a potential source of hydro-electric power in the Chenab River only a few miles distant, and coal is available on the spot.

Antimony

India.—The antimony deposit of Thabyu, Amherst District, Burma, is described by A. M. Heron (*Rec. Geol. Survey, India*, 1921, **53**, 34). The deposit is situated close to the Siam frontier, and is found in black slates, striking W.N.W. and dipping 40°–70° S.S.W. The largest lode, 20 ft. in thickness, has been followed for over 600 ft. in length. The ore is stibnite, in bunches of radiating or parallel crystals, and in massive aggregates, and from its outer surface to several inches in depth consists of secondary antimony ochre, either cervantite or stibiconite. The gangue is a yellow and white calcareous chert, showing distinct brecciation. Two analyses yielded respectively 60·45 and 61·59 per cent. of antimony. The deposit appears to be of economic importance.

An occurrence of antimony at Lebyin, close to the Shan State boundary, seems to be of no value.

A few tons of antimony ore were raised from the Southern Shan States in 1908 and 1909. According to H. Cecil Jones (*Rec. Geol. Survey, India*, 1921, **53**, 44) the only deposit that may possibly be of economic value lies south of the village of Naking. The ore is found along a line running nearly N. and S. A sample of 3½ tons raised in 1909

assayed 35·42 per cent. of antimony, proving it to be of low grade.

Asbestos

Union of South Africa.—In the *S. Afr. Min. and Engin. Journ.* (Sept. 24, 1921, p. 99), an asbestos property in the Transvaal is described. Situated sixty-five miles by road south-east of Pietersburg, the nearest station, it lies between two ridges of dolomite and quartzite respectively, belonging to the Transvaal system. The beds strike east and west and dip south, and are cut across the strike by six river-valleys down to 2,600 ft. in depth, thus affording very fine exposures. Asbestos veins occurring in banded iron-stones are exposed over the entire eight miles of this property, and probably extend over a belt of country 100 miles long.

Both crocidolite (blue) and amosite (grey) varieties of asbestos have been found in this belt, the latter being found both above and below the former. Mining at present is confined to one lode only (in McPie valley), to a width of 5 ft. containing about 11 per cent. of asbestos, varying from 2 in. in length downwards. A short account of the treatment of the crude material for market is given, several grades being produced. Transport is the only serious problem with which this venture is faced.

Samples of chrysotile asbestos from deposits near Kaapsche Hoop, Barberton District, Transvaal, have been received recently at the Imperial Institute. The material proved to be of excellent quality, great fibre length and very tough. An abstract of an account of the deposits given to the Geological Society of South Africa, by A. L. Hall, is published in *S. Afr. Min. and Engin. Journ.* (Oct. 15, 1921, p. 204). The asbestos occurs in serpentines of the Jamestown Series about 12–15 miles from Godwan River Station, the fibre-line extending for 3 miles eastwards from the slope of the Drakensberg and following a line generally corresponding to the contact between two varieties of serpentine. The band reaches up to 15 ft. in thickness, and is crowded with seams parallel to the contact-plane. Near the contact the seams are very numerous (up to 30 per foot), but they diminish in number and increase in width at a distance from it. "The economic importance of these deposits lies in the large quantities of ribbon rock available, in the high flexibility and general superior quality of the fibre, and in its high proportion of spinnable length" (i.e. over ⅜ in.). A plant for milling and screening, which is now working, furnishes seven grades of fibre down to ⅛ in.

A rich discovery of fine, white, silky asbestos associated with pure zeolite has been made on the farm Edendale, 2 miles from Rayton Station, Pretoria district (*S. Afr. Min. and Engin. Journ.*, Oct. 22, 1921, p. 254).

Borax

United States.—According to the *Canadian Min. Journ.* (Sept. 2, 1921, p. 704), deposits of colemanite (the chief source of borax) have been examined by the United States Geol. Survey in S. Nevada. There are deposits in two areas, both of which are in the Muddy Mountains, one in the White Basin district just east of Muddy Peak, and the other, larger, deposit in the Callville district, 6 miles south of Muddy Peak. The beds exposed range up to 2½ ft. in thickness, and a large quantity of commercially valuable material is apparently present. In the Callville district the bed of colemanite has a thickness of from 10 to 18 ft., and its outcrop is visible for about 3,000 ft. along the rim of an eastward-trending canoe-shaped syncline, where it consists essentially of solid layers of the mineral alternating with layers of paper shale or limestone. The deposit as a whole is expected to show 30–50 per cent. of pure colemanite.

Coal

Australia.—The Walloon coals (Jurassic), immediately north of Roma, in the Bowen River district, Queensland, and those of the Upper and Middle Bowen Series (Upper and Lower Permo-Carboniferous respectively) have been described recently by H. I. Jensen (*Queensland Govt. Min. Journ.*, Mar. 15, 1921, p. 93, and Oct. 15, 1921, p. 406).

The Walloon coals are in three horizons—upper, middle and lower. The upper, met with in the Roma bore at a depth of 700 ft., and the middle divisions are very thin and poor, but the seams of the Lower Walloon are of good quality. The most easily accessible and the best seam so far located has been intersected in Boyd's and Ferguson's wells, and in other wells and water bores near the railway. It is from 3 to 4 ft. in thickness, and a sample, on analysis, yielded the following percentages : Moisture, 5·0 ; volatile matter, 40·5 ; fixed carbon, 49·7 ; ash, 4·8.

In a gully running into Carnarvon Creek there occur two fine seams of coal of the Upper Bowen series. One was estimated to be about 8 ft., and the other (60 ft. lower in the series) 4 ft. in thickness. The upper seam yielded the following percentages : Moisture, 10·7 ; volatile hydrocarbons, 31·1 ; fixed carbon, 53·9 ; ash, 4·3. Calorific

value, 11,164 (B.T.U.); water evaporated at and from 212° F. by 1 lb. coal, 11·6 lb.; the coal is non-coking.

The coals of the Middle Bowen coal-measures are well represented on Consuelo Creek, 7 miles north of Rewan. The upper seam is estimated to be 10 ft. thick, and the lower seam (40 ft. lower in the series) 3 ft. 6 in. thick. An average sample of the two principal beds gave the following results on examination: Moisture, 10·8; volatile hydrocarbons, 29·8; fixed carbon, 52·3; ash, 3·8 per cent.; calorific value, 9·918 (B.T.U.); water evaporated at and from 212° F. by 1 lb. coal, 11·13 lb. The sample did not coke.

One of the important Permo-Carboniferous coal seams described constitutes a new find. The data obtained by Jensen greatly increase the area of the known coal resources of the State.

In the Imperial Institute Monograph on *Coal*, J. H. Ronaldson describes the enormous lignite deposits of Latrobe Valley, Gippsland, Victoria, Australia, and refers to the Report of the Advisory Committee on Brown Coal, Victoria, 1917, in which the opinion is expressed that power generated from the Gippsland deposits could be transmitted to Melbourne, a distance of 82 miles, and sold to existing power-houses at about 0·326*d*. per unit.

The scheme advocated in the Committee's report has been adopted by the Government of Victoria, and came into operation in January 1919 ("Power for Victorian Industries," *Suppl. to Indust. Australian and Min. Standard*, Mar. 17, 1921).

The scheme, which is controlled by Electricity Commissioners appointed by the State, involves the immediate development of the Morwell lignite or brown-coal-field by the establishment of a power house adjacent to the deposits, and the construction of a transmission line to Melbourne, power to be available in that city by 1923. This work is to form the nucleus of a general power service extending throughout the whole State, eventually bringing into use all the power resources, having for their base either coal or water.

Not only will the lignite be used for the generation of electrical energy, but briquettes will be made for steam-raising and other factory purposes, as well as for domestic use. Various distillation tests have been carried out by the Government at different times, and the possibility of using the surplus gas in boiler furnaces, the disposal of the by-products, and the use of pulverised lignite for steam-raising purposes, have received the consideration of the Commissioners, but, for the present, the main steam-raising

plant will burn the lignite on grates, according to standard boiler practice, after drying it in a special way by the waste gases.

Prior to 1916, 40,000 tons of lignite were removed at Morwell and sold ; since 1916, when operations on a larger scale were commenced, 400,000 tons have been raised. The mine is being worked by open cut, on the bench system. The overburden is from 30 to 90 ft., and the seam from 140 to 240 ft. in thickness. It is estimated that there are about 480,000,000 tons of coal in the area, which, however, is a very small fraction of the country proved to the east and south of the field.

Spain.—The lignite deposits of Rubielos de Mora, province of Teruel, Spain, are described by Juan Gavala (*Bol. Inst. Geol. España*, 1921, **42**, 265). The beds, which have been exploited for a good many years, form part of a series of Tertiary (Oligocene) sediments filling a depression or basin in Cretaceous beds formed by subsidence. The lignite occurs in the lower portion of the basin, at its extreme eastern end. At Arroyo del Molino there are two main beds of lignite, separated by clays, the upper one about 4 ft., and the lower one 7½ ft., in thickness. These beds dip from 10° to 12° S.E. In the bed of the River Nogueruelas the dip is 40° S.E., the upper seam being here 9½ ft., and the lower one 2½ ft., thick. The total thickness of coal in the area is estimated to be 33 ft.

The depression or basin at the top of the Cretaceous formation was once a lake, and later must have been gradually filled with detrital material. The lignite formation may be regarded as accidental, and it only extends for a length of about 2,000 ft. The probable reserves are estimated to be 3,500,000 tons, confined to the Julia and Matilde concessions and the excess ground (*demasía*) between them. The lignite is of inferior quality, but it can be profitably won at the present high price of fuels.

Copper

Canada.—The Maskwa (Bear) River copper-nickel deposit in south-eastern Manitoba is described by W. S. McCann (*Canada, Geol. Survey Summ. Rept.*, 1920, Part C, p. 19). The deposit may be described as an elliptical inclusion of greenstone and norite in granite and gneiss, the margins of which are mineralised with copper-nickel sulphides. The metallic minerals are pyrrhotite, pentlandite (iron-nickel sulphide) and chalcopyrite. The Maskwa or Bear River deposits are analogous to those of Sudbury, Ontario. Seven samples yielded from 0·16 to 3·23 per

cent. of copper, and from 0 to 1·68 per cent. of nickel. Four of these samples contained no platinum, while three yielded respectively 0·01, 0·02 and 0·03 per cent.

Other copper-nickel deposits are near the Oiseau River, in the same region. A sample of pyrrhotite-pentlandite yielded 2·92 per cent. nickel, and one containing 5·85 per cent. nickel is reported by E. V. Neelands from the Oiseau Lake vicinity.

Since the above report was written, a series of test pits have been sunk on the Devlin and Chance claims of the Oiseau River copper-nickel deposits in order to determine the nature and extent of the unweathered minerals (*Canadian Inst. Min. and Met. Monthly Bulletin*, 111, July 1921, p. 592). One pit sunk 20 ft. in norite exposed various quartz veins carrying chalcopyrite. Another pit, sunk 20 ft. in norite, shows many slickenside slip-faces or shearings, while quartz carrying some free gold, pyrrhotite, magnetite and chalcopyrite occurs close by.

The magnetite band, 2 to 3 ft. wide, runs 150 ft. north, where it is opened on by a third pit, and is seen to contain minor amounts of chalcopyrite. The granite contact is close to the north. Along the contact there are eight more pits, from 3 to 18 ft. in depth. They all contain pyrrhotite, with small quantities of chalcopyrite. The Oiseau River occurrence may be regarded as a prospect favourably mineralised over a long contact zone. It is reported that stripping operations will be completed with a view to the future development of the ore-body by diamond-drill.

Gold

Canada.—A. G. Burrows (*Canadian Min. Journ.*, Aug. 5, 1921, p. 621) describes part of the Goudreau gold area, which is in the Michipicoten district, Ontario. The gold occurrences at Webb (or Iron) Lake in that district have already been described by W. H. Collins (*Canada, Geol. Survey Summ. Rept.*, 1918, Part E, p. 29), and, although Burrows examined the claims of that particular locality, sufficient work had not then been done on any of them to determine their value.

In April, 1921, gold was discovered near Murphy Lake. The formation consists of basic volcanics of Keewatin age, intruded by quartz-porphyry and dolerite. One vein strikes N. 30° W. and dips 60°–80° S., is from 7 in. to ft. in thickness, and has been traced for 800 ft. along the outcrop. The wall-rock is altered and mineralised. The quartz carries pyrite, chalcopyrite and pyrrhotite. A number of assays of samples obtained at points along the

various veins showed gold ranging in value from a few cents to $28 per ton. Specimens of quartz, carrying a high percentage of sulphides, gave $31·20 and $48·80 per ton in gold. Extensive work will be necessary to determine possible ore shoots along the veins, since large portions of them are covered by drift.

Graphite

Kenya Colony.—A brief and popular illustrated account of graphite deposits at Tulimani Hill, Machakos District, is given in *The Farmers' Journal*, Aug. 18, 1921, p. 19. There is an enormous body of ore close to the surface, occurring apparently in a seam whose greatest width is 110 ft., the present working face being 75 ft. across; at present the ore is quarried, but bores have been put down 75 ft. without reaching the bottom. It seems that the ore is not refined at present, but it is intended to erect refining plant at Nairobi, where graphite products will also be manufactured. A quantity of ore has been used successfully for making refractory bricks locally, and, in view of the abundance of cedar wood in the vicinity, it has been suggested that pencils might be manufactured remuneratively at the Nairobi factory.

Iron

India.—H. H. Hayden in the quinquennial review of the mineral production of India for the years 1914 to 1918 (*Rec. Geol. Survey, India*, 1921, **52**, 115) gives an account of the iron-ore deposits from which the Tata Company's ironworks are supplied.

There are three principal deposits, viz., Gurumaishini, Okampad (Sulaipat) and Badampahar, all in the Mayurbhanj State. The ore deposits have almost all been found to take the form of roughly lenticular bodies of hæmatite, with small amounts of magnetite in close association with granitic rocks.

The Gurumaishini Hill reaches an elevation of 3,000 ft. above sea-level at its highest point. Large bodies of iron ore occur in this hill, and 15,000,000 tons have been proved to date. The average composition of the ore is: Iron, 60·00; phosphorus, 0·082; and manganese, 0·42 per cent.

Okampad is a conspicuous peak 12 miles south-west of Gurumaishini. The ore deposit is situated just west of the Khorka River, where the latter breaks through the Sulaipat-Badampahar Range. The ore-body occurs as a single great lens covering a superficial area of about 300,000

sq. ft. There are, besides, two outliers and about 165 acres of rich float ore. The average percentage composition of four samples of the ore was: Iron, 67·65; silica, 1·58; phosphorus, 0·043; sulphur, 0·012.

The Badampahar deposit occupies a peak in the Sulaipat-Badampahar Range, 8½ miles from Okampad. This also is a single great lens of ore roughly 3,000 ft. long by 500 ft. broad, with many smaller outliers occupying the crest of the peak; masses of rich float ore are found on the slopes for 600 ft. downwards. The ore is associated with banded quartzites and quartz-iron-ore, with abundant basic holocrystalline rocks. The lower ground to the north-west is said to be completely occupied by granite. A railway is being made to this deposit.

In the same number of the *Records* (pp. 124–126) information is supplied regarding the iron-ore resources of Mysore State. Of these resources, the hæmatite ores of the Bababudan Hills are considered to be by far the most abundant. They are also of good quality, but vary considerably in the amount of phosphorus they contain.

The Mysore Government is now erecting a blast furnace of a modern American type at Benkipur in the Shimoga district, capable of a daily output of 50 tons of pig-iron. It is proposed to use charcoal as fuel, and for making this a wood distillation plant is being erected on a scale for carbonising 100,000 tons of wood annually. Limestone or dolomite for fluxing will be obtained from Kohlapur in the Tumkur district.

The production of iron will be under the management of the Tata Iron and Steel Co., who will act as agents for the Mysore Government under control of a board of management.

The iron ore will be obtained chiefly from Kemmangundi on the Bababudan Hills, and will be mined and supplied under the direction of officers of the Government Department. The ore will be conveyed from the mine to the foot of the hills by aerial tramway, and will be hauled thence to Benkipur, a distance of 25 miles, on a light railway. As regards the quantity and quality of ore available at this point, it is stated that a few million tons containing 64 per cent. of iron could probably be obtained if it were worth while to select so high a grade, and that of ore running about 60 per cent. of iron probably 25,000,000 to 50,000,000 tons are available; of ore containing about 55 per cent. of iron it would be safe to estimate 100,000,000 tons, but probably there actually exists several times this amount.

Uganda.—Some of the iron-ore deposits of Uganda were briefly described in this BULLETIN (1910, **8**, 301), and an analysis was given of a specimen of surface ore as used by the native blacksmiths for producing iron. This analysis shows the sample to be relatively low in iron, and to contain 0·69 per cent. of phosphorus. A sample taken subsequently from a depth of 5 ft. below the surface showed considerable improvement in the iron content, but was still higher in phosphorus. The Masindi district from which these samples were obtained is said to contain enormous deposits of ore of this type. In the *Ann. Rept. of the Geol. Dept., Uganda, for the year ending March* 31, 1921, reference is made to the iron-ore deposits of the Protectorate, the native iron industry, and the prospects for a local iron-smelting industry on modern lines. The report indicates that there is a large quantity of ore of the lateritic type capping many of the hills, but, apart from this, hæmatite and magnetite are locally abundant and of economic importance. It is suggested that a small modern iron-smelting furnace might be successful in meeting local requirements. High-grade ore exists and also dolomite for fluxing ; there is also water transport for the movement of these materials, but the fact that coal has not yet been found in the country would necessitate the employment of charcoal. The question of electric smelting of the iron ores is also under consideration, and it is said that in one district it should be possible to produce pig-iron by this means at £6 a ton.

South-West Africa.—In *South African Journ. Indust.* (1921, **4**, 747), P. A. Wagner gives an account of the iron-ore deposits in the Namib Desert from 10 to 16 miles south-east of Walfish Bay, South-West Africa. The ores are highly siliceous and not suitable under present conditions for use as a source of iron. The deposits are all of sedimentary origin, and with one exception—a deposit of magnetite-garnet rock—consist of itabirite belonging to the fundamental complex. Sporadic occurrences of gold and silver are scattered through the itabirite deposits, but, so far as these have been tested, they are nowhere in sufficient quantity to be profitably extracted. A sample of ore taken by the author, of a richness above the average and probably representative of the grade that might be obtained by selective mining and sorting, gave on analysis : Iron, 57·7 ; silica, 17·6 ; phosphorus, 0·05 ; and sulphur, 0·35 per cent.

Canada.—In *Summ. Rept.*, 1920, *Part A, Dept. of Mines, Geol. Survey, Canada*, J. D. Mackenzie describes the limo-

nite deposits of Taseko Valley, British Columbia, situated in the eastern range of the coast mountains, nearly 100 miles north-west of Lilloet. The deposits consist of several separate and distinct beds in the valleys of the Taseko River and its tributaries. Seven localities have been mapped, five of which are grouped in an area of about 25 square miles to the north of the Taseko River, whilst the others are on the south side of the river, and north-west of the first area. The region is somewhat inaccessible in winter by the ordinary route owing to the passes being blocked by snow, but there is an alternative, though longer, route.

The deposits are of "bog iron ore" and consist of sheets of brown limonite of varied shape, size and thickness, lying parallel to the surface. The ore is somewhat friable and mining produces a large amount of "fines." Many samples were taken of the various deposits, analyses of which show the iron contents to range from 41 to 51 per cent., with phosphorus either absent, or present in very small quantities. The greater portion of the ore contains about 50 per cent. of iron. The quantity of ore available is estimated at 10,716,000 cub. ft.

In *Bulletin, Canadian Inst. Min. and Met.*, Oct. 1921, p. 853, reference is made to a subject which may prove of considerable importance to the Rossland and adjacent districts of British Columbia. A deposit of hæmatite extending over an area of 600 acres has been acquired by the North-Western Iron and Steel Co., a Washington State corporation. This deposit is found along a dyke said to be fairly continuous from a point on the Columbia River, in the Northport mining district in United States territory, to some distance within the British Columbia boundary. Analyses of twelve samples of the hæmatite taken from different points throughout the deposit, conducted by a number of different assayers, show an average of 56·8 per cent. of iron.

Sweden.—It is reported in *Eng. and Min. Journ.*, Dec. 3, 1921, that investigations of the Mertainen iron-ore fields in North Sweden, which had been formerly explored by a Swedish Government Commission, have now been completed. It was found that the deposits contain valuable ore, rich in iron and low in phosphorus, analyses of samples showing an iron content of from 65·5 to 68·5 per cent., and a phosphorus content of 0·09 per cent. Estimates place the available tonnage at 35,000,000 to 40,000,000 tons.

Finland.—According to the *Eng. and Min. Journ.*, Dec. 3, 1921, considerable iron-ore deposits have been

discovered at Kittila in Finland. The Finnish Geological Society started investigations there in the summer of 1920, and a report of the results has recently been issued. The Kittila ores differ in properties and appearance from the iron ores of Northern Sweden. Over an area of from 4,000 to 8,000 sq. miles, bodies of rich iron ore have been found extending for several hundred metres in length with a width of from 40 to 60 metres. In the upper strata the ore is estimated at 51,400,000 tons, and in the lower, at 17,700,000 tons.

Lead

Canada.—In *Summ. Rept.* 1920, *Part A, Dept. of Mines Branch, Geol. Survey of Canada*, W. E. Cockfield reports the result of an examination of the Keno Hill mineralised area in Mayo district, Yukon. The country rock of the greater part of this area consists of crystalline schists intruded by igneous rocks. The solid rock formations are nearly everywhere marked with superficial deposits, making prospecting difficult. Near the hillocks known as Keno Hill, Minto Hill and Monument Hill, the strata are bent nearly at right angles, and this flexure is probably responsible for numerous small faults, in the fissures of which silver-lead ore has been deposited. Both longitudinal and transverse fault systems are found. The former is mineralised with arsenopyrite, galena and manganese minerals; the latter is similarly mineralised, but contains also blende and a silver-ore mineral not yet positively identified, but believed to be freibergite, a sulphantimonide of copper and silver. The transverse faults have so far proved more productive. The galena usually carries from 200 to 500 oz. of silver to the ton, but, where the supposed freibergite is present, it may contain as much as 2,000 oz. The transverse fissures are usually quite short and are unlikely to continue in depth, a circumstance which is partly counterbalanced by their large number.

Lithographic Stone

France.—An account is given in the *Stone Trades Journal*, Aug. 1921, p. 63, of attempts to find material in France to compete with Bavarian lithographic stone. The required properties for good stones are discussed and descriptions are given of the materials quarried at Vigan (Gard) and Montdardier. The objection to the former is its great porosity, and to the latter its dark spotted colour. Mechanical methods of quarrying are adopted of which details are given.

The result of these attempts has confirmed the fact that there is no lithographic stone in France comparable with the Bavarian material from Solenhofen.

Magnesite

Greece.—A description of the magnesite deposits of the Island of Eubœa by H. C. Boydells is given in *Eng. and Min. Journ.* (1921, **112**, 771). The deposits, which are included in a belt of serpentine, are situated in the northern part of the island, and stretch for about 18 km. across it from Limni to Kymassi, sometimes reaching a width of 7 km. The serpentine resulted from the alteration of a peridotite (rich in magnesia) which was intruded into cretaceous limestones, and the magnesite has been formed from the replacement of the serpentine along fault or shear lines by the action of percolating waters rich in carbon dioxide. These lines of movement are in two general directions at right angles to each other, approximately N.-S. and E.-W., the former being the more important. The chief workings are at Mantoudi (the largest), Daphnopotamous (the purest), Limni, Pyli, Afrati, and Hagia Anna. In general the deposits are characterised by irregularity of the hanging wall, giving the appearance of a series of connected lenses, the presence of rounded inclusions of serpentine in the magnesite, and the denseness of the magnesite, which is never spongy or vesicular.

The mineral itself is very finely crystalline, and is generally pure white. All the magnesite mined is exported, being shipped either crude or calcined. In the former case it is generally guaranteed to contain 94 per cent. of magnesium carbonate, but commonly has 96 per cent. or more, and is shipped in bulk, whereas the latter is bagged in two grades, viz., caustic burned and dead burned. In all districts, shipment has to be done by means of lighters. Details are given as to the methods of mining employed at the various localities, and also of the conditions of labour.

Manganese

India.—In *Rec. Geol. Survey, India* (1921, **52**, 147), L. L. Fermor reviews the production and disposal of the manganese ore output of India for the quinquennial period ending 1918. Much information regarding the manganese ore deposits and the manganese position generally in India is given in Chapter II of the Imperial Institute Monograph on *Manganese Ores*, published in 1919, but the above review supplements this with statistical and

other information not then available. The average annual production of manganese ore for the quinquennial period under review was 577,457 long tons, as compared with 712,797 long tons for the preceding five years, the decrease being attributable to the difficulties of export arising from the war. During the same period the development of a ferro-manganese industry has made considerable progress. In 1918, a quantity of ferro-manganese amounting to 12,114 tons was produced for the domestic iron and steel industry. In other directions, changes in the distribution of Indian manganese ores have occurred. Exports to Belgium, Germany and Austria ceased from 1914, and those to France and the United States decreased. In the meantime the United Kingdom has been able to absorb practically the whole of the ore available for export.

It is shown that Indian manganese ores, compared with ores obtained from other principal sources, are the highest in manganese, second in regard to low silica content, and highest in phosphorus of all except Russian ores. It is suggested, however, that inasmuch as buyers are willing to pay a premium on ores containing less than a certain percentage of silica, but not in the case of phosphorus, the presence of silica is considered more deleterious than that of phosphorus.

In the period under review, no new manganese fields were discovered in India and no important new deposits found. Only one new deposit, at Pani, Chota Udaipur, Bombay, has been opened up, on which production commenced in 1914, whilst one deposit of the gonditic type, which had yeilded 195,763 tons of ore, was abandoned in 1918; another, which had yielded 66,212 tons of very high-grade ore, was abandoned in 1919. Generally, only the superficial deposits such as those of Vizagapatam show a declining yield. Deposits of the gonditic type show little sign of deterioration in depth, except where structural features intervene. In some cases a very slight decrease in manganese and a slight increase in silica and phosphorus may be found with increase of depth.

Mica

India.—In "Notes on Mica" (*Bulletin Indian Ind. and Lab.*, No. 15, 1921), by J. Coggin Brown, special attention is paid to the industrial uses of mica, the specifications and standards of quality demanded in the consuming trades, and the methods of marketing. Brief notes are given on the characteristics of the mineral, and the chief Indian localities producing it. With the exception of a

small quantity of phlogopite from Travancore, all the mica mined in India is muscovite.

Much information is given as to the uses of mica, and the opinions of manufacturers and others on the comparative utility of specific varieties are quoted. Methods of trimming, grading, sizing and splitting mica are described, as well as mica preparations, substitutes, prices, and competing sources of supply. The *Bulletin* contains statistics, and concludes with a summary of the outlook for Indian mica.

Australia.—According to reports from Cloncurry, Queensland (*Queensland Govt. Min. Journ.*, 1921, **22**, 339, 380, 387, 396), mica of good quality has been discovered in the Camooweal district near Lagoon Creek Hut, via Duchess (Camooweal road). Samples sent by the Government Assayer to manufacturers at Sydney were pronounced unsuitable for electrical work, but equal to Brazilian or Indian mica for certain other manufacturing purposes. Arrangements for financing operations have been made, and a preliminary sample of one ton has been sent to Sydney. Notice of a previous discovery near Cloncurry was given in this BULLETIN (1916, **14**, 485).

Nickel

Canada.—A summary of a *Report* by the Geological Survey of Canada on the Maskwa (Bear) River copper-nickel deposit in south-eastern Manitoba is given in the section on copper (p. 539).

Oil Shale

Australia.—According to H. I. Jensen (*Queensland Govt. Min. Journ.*, Mar. 1921, p. 92, and Oct. 1921, p. 401), oil shale occurs immediately north of Roma, and still further north, in the Carnarvon Ranges. The Walloon area (Jurassic), immediately north of Roma, appears to contain numerous seams of kerosene shale or torbanite. According to Jack, oil shale occurs on Injune Creek; whilst in Bungeworgorai Creek, near its junction with Steward Creek, Jensen found a bed, probably 2 ft. in thickness, which yielded 44·8 gallons of oil to the ton. In the Upper Bowen series (Upper Permo-Carboniferous), near Carnarvon Creek, there is a bed of kerosene shale showing a thickness of 3 ft., which is 70 ft. vertically above an upper seam of good coal. Below the oil shale is a 6 in. band of inferior shale, and then 6 in. of oil shale, and 50 yards higher up the creek is a 6 in. seam. A sample of the

weathered surface of the 3 ft. body yielded 54 gallons of oil per ton. From the above it appears that a fine body of kerosene shale has been discovered of better quality than any hitherto located in the state.

Spain.—The bituminous shale deposits at Rubielos de Mora, in the province of Teruel, have recently been described by Juan Gavala (*Bol. Inst. Geol. España*, 1921, **42**, 265). They occupy the middle portion of a basin of Oligocene sediments lying upon Cretaceous rocks. The bituminous shale and intercalated clay zone has a breadth of about one mile, a length of four miles, and a thickness of about 400 ft. The western half only of the zone is exploitable, the richest portion having a length of about 1,300 ft. The probable reserves are estimated at 24,000,000 tons, which, with a 4 per cent. yield, would produce 960,000 tons of crude oil.

Petroleum

Australia.—The geology of the country north of Roma, in the north-east of Maranoa Province, Western Queensland, in relation to the question of oil wells, was described by H. I. Jensen early in 1921 (*Queensland Govt. Min. Journ.*, Mar. 15, 1921, p. 92), and, later in the year, he compared Western Queensland with the mid-continental oil-field of the United States (*op. cit.*, Aug. 15, 1921, p. 324). According to this geologist, the structure is that of a gentle monocline, dipping from north to south in the Roma district, and from north-east to south-west in the Maranoa Basin. This monocline is gently folded into terraces by the dip steepening in certain belts running at right angles to the dip, and flattening in other parallel belts. In the Lower Walloon are highly carbonaceous deltaic deposits, very favourable for oil production, and the porous sandstones both above and below this series are very suitable for the storing and preservation of oil.

The mid-continental field of the United States draws its oil supplies from the Lower Palæozoic and Permian strata, whilst those which probably exist in the Roma district would be drawn from the Jurassic, yet the structures in both countries are very similar, the following characteristics being common to both :- (1) Monoclinal structure ; the observed dips are very nearly the same in both countries ; (2) minor structures, e.g. wrinklings or undulations more or less parallel to the line of strike, and the uplifts ; (3) entire or almost entire absence of seepages of oil at surface ; (4) nature of the strata—shales, sandstones, thin limestone

and workable coal. In the United States, oil sands occur as well as the above, but similar sands have not yet been fully demonstrated for Roma.

With regard to oil-prospecting in Queensland, Jensen remarks:

"By receding northwards towards the edge of the basin and boring, say, in the region of Orallo, we shall not only strike the probable petroliferous beds at a depth of about 2,000 ft., which seems ideal for oil preservation, but we have the additional advantage of commencing boring in drier strata, namely in the outcrop of beds underlying the principal artesian water zone and overlying the principal petroliferous zone."

Boring was started at Roma in 1915. In September 1919 the stem of the drill broke when a depth of 3,705 ft. was reached. In trying to remove the obstruction, there was a heavy flow of gas, which forced the broken tools upwards 45 ft. All attempts to remove the obstruction having failed, it was decided to continue the boring at a depth of 3,000 ft., deviating so as to pass the jammed tools. The total cost of the Roma bore for the six years ending June 30, 1921, has been upwards of £30,000.

Argentina.—The Comodoro Rivadavia producing area is described in the Imperial Institute Monograph on *Petroleum* (1921, p. 80). According to J. B. Powers (*Petroleum World*, Nov. and Dec. 1921, pp. 452 and 493), a gusher was struck in a new area in February 1921, several miles from the principal producing centres. The flow of oil was at the rate of about 3,500 cub. metres per day. The oil is found in a sandy mixture containing some loam and clay in a stratum approximately 100 ft. in thickness. The density of the oil varies from 0·916 to 0·932.

The oil-fields of the northern provinces of Salta and Jujuy are described by G. S. Brady (*Petroleum World*, Dec. 1921, p. 495). Analyses of the oils, published in 1919, showed both asphalt and paraffin bases, and densities ranging from 0·847 to 0·956. There is apparently little doubt of the richness and great extent of the deposits, and it may be regarded as a virgin field.

Platinum

Union of South Africa.—According to E. M. Weston (*Eng. and Min. Journ.*, Nov. 19, 1921, p. 815), platinum, alloyed with iridium and iron, has been discovered in decomposed diabase dykes near Cala, situated 80 miles north of Queenstown in the north-east of Cape Province.

The metal is stated to be distributed over a wide area, the average content being several pennyweights per ton. The platinum is usually in a very fine state, but nuggets are found occasionally.

Potash

France.—The production of potash in Alsace during 1920 showed a notable increase over that of 1919, the figures for the two years being as follows (*Amer. Fert.*, June 4, 1921, p. 94):

Grade.	Production (in tons of pure potash, K_2O).	
	1919.	1920.
Sylvinite (12–16 per cent. K_2O) . . .	262,779	664,019
Rich sylvinite (20–22 per cent. K_2O) . .	163,714	335,820
Potassium chloride (50–60 per cent. K_2O) .	38,114	61,352
Total	464,607	1,061,191

Poland.—According to the *Amer. Fert.* (June 22, 1921, p. 577), the Kalusz potash mines, about 45 miles from Lemberg, are now being worked by the Kali Company of Lemberg. Formerly the output of potash salts was limited by agreement with the German Government to the quantity that could be consumed locally. The output during 1914 amounted to 6,000 wagons (of unstated capacity) of salts, but no further production was made until 1919. At the present time the mines give work to 340 men, and production is at the rate of about 5,000 wagons of salt per annum. This amount, it is stated, could easily be increased tenfold if more railway wagons were available.

United States.—For several years investigations have been in progress in order to ascertain whether potash is likely to occur in economic quantity in the Permian strata of West Texas, and the results of this work have been summarised by J. A. Udden (*Chem. and Met. Eng.*, 1921, **25**, 1179). In 1915, a boring at Boden, Potter County, at a depth of 875 ft., gave a red salt with 9·2 per cent. of potash (K_2O), whilst another boring in the county at 1,700 ft. also gave a red salt containing 6·1 per cent. of potash. Borings in Midland County gave somewhat similar material at about 2,500 ft. Potash-bearing salts have also been encountered by borings in Loving, Ward, Dawson and Borden Counties. Soluble potash minerals have thus been found in borings over 300 miles apart,

but further work is required in order to determine whether the deposits located are of sufficient thickness to be economically important.

Silver

Canada.—An account of deposits of silver-lead ores in the Mayo district, Yukon, is given in the section on lead (p. 545).

Sulphur

Finland.—A note in the *Mining Journal* (Oct. 1, 1921, p. 721) reports the discovery of a large deposit of pyrites in the Suistamo district. The deposit is said to be of great economic value, and it is being geologically examined. The State is considering the erection of a sulphuric acid factory in the neighbourhood.

Tin

Union of South Africa.—The Mutue-Fides-Stavoren tin-fields, Transvaal, briefly referred to by G. M. Davies (*Tin Ores:* Imp. Inst. Monograph, 1919, p. 55), have recently been described in detail by Percy A. Wagner (*Union of South Africa Geol. Survey*, Memoir 16, 1921). The deposits occur in the granitic and other rocks of the Igneous Complex of the Bushveld, and in the quartzites (Waterberg) lying thereon. The zone extends in a general N.N.W. direction for a length of 9½ miles, and for a width of 3 miles. The deposits are classified as: (*a*) Regular tabular replacement veins; (*b*) irregular replacements or impregnations; (*c*) pipes; (*d*) "eyes," pockets and "ore-boulders."

The Mutue Fides mine has so far produced the bulk of the cassiterite raised from these tin-fields. Most of the ore extracted has come from two large flat-dipping deposits of class (*a*) which follow fractures in the granite, the richest ore occurring near the intersection of these fractures with others which are nearly vertical.

The extravagant expectations originally entertained in regard to the potentialities of the fields have not been realised, and although there is no prospect of their rivalling the Northern Waterberg or the Rooiberg-Leeuwpoort tin-fields, they are likely to continue for many years to yield moderate quantities of cassiterite, scheelite, and copper ores.

Uranium

Canada.—Pitchblende containing 2·3 per cent. of uranium has been found about 4 miles east of Parry

Sound in Northern Ontario, in a pegmatite dyke, which cuts through the country rock (*Oil, Paint and Drug Rep.*, May 2, 1921, p. 48c).

Czecho-Slovakia.—An Anglo-Czech company has been formed to develop the well-known Joachimsthal pitchblende deposits (*Mining Journ.*, 1921, **134**, 579). A company has also been formed in Prague for the purpose of manufacturing radium and other products from pitchblende. The Government of Czecho-Slovakia has decided to set aside about 12,000,000 kronen to be applied to the improvement of processes for the treatment of uranium ore (*Mining Journ.*, 1921, **134**, 687).

Belgian Congo.—At the annual meeting of the Union Minière it was stated that work had been restarted on the thin stringers of uranium ore known to occur in the copper deposits at the Luiswishi mines, that ore had also been found at Shikolowe, 25 km. south-west of Kikasi, and that prospecting was in progress (*S. African Min. and Eng. Jour.*, 1921, **32**, 1643).

NOTICES OF RECENT LITERATURE

FIJI: ITS PROBLEMS AND RESOURCES. By Major W. A. Chapple, M.D., Ch.B., M.R.C.S., D.P.H., R.A.M.C. (retd.). Pp. 189, 8vo, 7 × 4¾. (Auckland, Melbourne and London: Whitcombe & Tombs, Ltd., 1921.)

Though often striking the reader as too uniformly optimistic in its estimate of the possibilities of Fiji, this readable little book, by a medical man with considerable experience of the Pacific, gives a very complete picture of the hygienic and agricultural conditions of the islands. The endemism of disease is curiously illustrated by yaws in the human subject, and by the moth blight (*Levuana iridescens*), an insect parasite confined to Viti Levu, in the case of the coconut palm. Though the Fijians have suffered grievously from measles and influenza introduced from elsewhere, the absence of malaria, yellow fever and sleeping sickness enables Major Chapple to recommend these coral-girt volcanic islands within the tropics for European settlement, just as the absence of anthrax, rinderpest and tick fever causes him to urge the extension of stock-raising. Hurricanes introduce an irremediable uncertainty into banana and coconut growing; but labour seems to present

the most generally serious difficulty in the problem of the development of the colony, and especially in sugar-growing, its leading industry. Although, in the author's opinion, the Fijian is a good sailor, he is not a good labourer; and it is considered, therefore, that there is a good opening in Fiji for Indian settlers. It is thought that if the influx of free Indian labour is discouraged, it will be replaced by Chinese or Japanese. Goats, pineapples and bamboo paper-pulp are dealt with as promising objects of industrial development, and the author warmly urges the claims of the extensive deep and sheltered harbour of Suva, both as a naval base and port of call in the South Pacific.

AGRICULTURAL PROGRESS IN WESTERN INDIA. By G. Keatinge, C.I.E., Director of Agriculture, Bombay Presidency, 1907 to 1921. Pp. xi + 253, 8vo, 7 × 4¾. (London: Longmans, Green & Co., 1921.) Price 6*s*.

This eminently readable and suggestive little volume is obviously written rather for the statesman and the administrator than for the actual cultivator of the soil. After pointing out the difficulty of evaluating such criteria of progress as the standard of living, the percentage of profit or the outturn per acre, the author gives a most interesting epitome of recent progress in Denmark, Germany, the United States, and the cane-sugar-growing countries, Hawaii, Formosa and Java, dwelling more particularly on such topics as agricultural co-operation, credit and education, manuring and irrigation. In India, on the other hand, progress is with difficulty measurable, inasmuch as the peasant keeps no accounts, consumes most of his produce, and sells the remainder in markets which make no statistical returns. The capricious character of the rainfall in the Bombay Deccan adds to the difficulty of estimating the extent of agricultural improvement; but within twenty-five years land has increased fourfold in value; rents have doubled; 3,000,000 acres under cotton have increased to 4,750,000 and 100,000 acres under ground-nuts to more than 200,000; irrigation wells have increased every year by nearly 4,000, and iron ploughs by the hundred thousand. The most serious drawbacks to Indian agriculture would seem to be the unlimited subdivision of the holdings, the bare fallows which for the most part take the place of manuring, and the caste restrictions on the slaughter, selection and employment of cattle. It may not be difficult to improve the quantity of milk produced, by the more extended use of ensilage; and so much has already been done to introduce co-operation in credit, in

the purchase of implements, seed, etc., and in breeding and insuring cattle, selling cotton, etc., that it may be hoped that remedies may be found for the dirty and adulterated condition in which milk, ghi, hemp and wheat are at present marketed. Concluding his survey with an admirable discussion of the human factor as influenced by race, climate, disease and institutions, Mr. Keatinge points out that the Bombay sugar-cane harvester or cotton-picker only accomplishes a third of the work per diem of one in the West Indies, whilst an operative in a Bombay cotton-mill does only from a sixth to a tenth of that done by a Lancashire worker. This is due partly to a uniformly hot, moist climate, partly to the joint family property that offers no inducement to individual initiative, partly to the prevalence of debilitating disease, such as malaria and hook-worm, but largely to that contentment with conditions only barely beyond the limit of famine which made the late Sir George Birdwood apostrophise "Happy India."

THE FLORA OF THE NILGIRI AND PULNEY HILL-TOPS. By P. F. Fyson, B.A., F.L.S., Professor of Botany, Presidency College, Madras. With 580 full-page illustrations and 4 maps by Lady Bourne, Mrs. Fyson and others. Vol. iii. Pp. xviii + 136. Plates 287–581, 8vo, 8¾ × 5½. (Madras: Superintendent, Government Press, 1920.) Price, Rs. 15 as. 6.

This volume is supplementary to those published in 1915, and deals with plants from the neighbourhood of Coonoor and down to 5,000 feet. As species previously described are again mentioned, the enumeration under each genus is here complete. The descriptions, which are in English, are clear and commendably brief, and keys are furnished to a few—too few—of the genera. The most remarkable feature of the work is, however, its wealth of illustrations—the outline drawings and dissections, a species to a page, being exceptionally good. The firm lines of those by Mrs. Fyson in the present volume are, we think, even better than those previously issued. The flora described is interesting as temperate in character, being characteristic of a high mountain area (6,500–8,500 feet) in a sub-equatorial latitude.

A HANDBOOK OF THE FOREST PRODUCTS OF BURMA. By Alex. Rodger, O.B.E., F.L.S., I.F.S., Conservator of Forests. Pp. ix + 128, 8vo, 9 × 5½. (Rangoon: Superintendent, Government Printing, 1921.) Price R. 1.

This is a useful list of the forest products of Burma, with superficial descriptions and references to further

details. Timbers (arranged systematically) occupy nearly half the volume; but there are also separate chapters on fuel, bamboos, tans, oils, fibres, medicinal and food plants, etc. Part II enumerates the species of trees that are reserved, the forest circles and divisions—a map of which would have been a welcome addition—and gives particulars of the cost of transport by rail, road and river, and an estimate of the amount of timber available. There are indexes of English, scientific and Burmese names.

MIKROGRAPHIE DER HOLZES DER AUF JAVA VORKOMMENDEN BAUMARTEN. Unter Leitung von Dr. J. W. Moll, bearbeitet von H. H. Janssonius. Fünfte Lieferung. Pp. 423, 8vo, 9 × 5¾. (Leiden: E. J. Brill, 1918.)

The first three parts of this valuable treatise, dated 1906, 1908 and 1911 and forming the first two volumes, were noticed in this BULLETIN (1912, **10**, 183), and the fourth part, dated 1914, in a later volume (1915, **13**, 332). The present part, together with the fourth part, constitutes the third volume and completes the description of the Calyciflorae. It includes descriptions of 126 species, belonging to nine different Families, 55 of them being myrtaceous, and no less than 44 belonging to the genus *Eugenia*. Among other well-known woods described are most of the mangroves, the myrobalans, the jarul of India (*Lagerstrœmia speciosa*) and the musk-tree of Fiji (*Marlea vitiensis*). For the readier identification of these equatorial woods it is, perhaps, regrettable that the cheaply produced schematic diagrams of structure are not given for every species. There are, for instance, only two for the whole of the genus *Eugenia*.

FARM MANAGEMENT: A TEXTBOOK FOR STUDENT, INVESTIGATOR, AND INVESTOR. By R. L. Adams. Pp. xx + 671, 8vo, 9¼ × 6. (New York: McGraw-Hill Book Company, Inc., 1921.) Price 20s.

This work, though characteristically thorough and comprehensive, belongs in conception, language and application entirely to the United States. Much that relates to the business aspects of farming, such as the consideration of local limitations of climate, soils, labour and capital, is, however, obviously of general application. The book is divided into two approximately equal parts, the first dealing with preliminaries, such as the choice, organisation and survey of the proposed farm, its equipment, calendar of operations and probable profits, and the second with the

book-keeping, marketing and law involved in carrying it on as a remunerative concern. The differing agricultural conditions of the various States of the Union are fully considered throughout; and, as in a final chapter the references are collected and arranged under the various chapter-headings so as to form a classified bibliography, and there is a full index, the work should prove serviceable for the American agricultural college students to whom it appears to be mainly addressed.

NUT-GROWING. By Robert T. Morris. Pp. vii + 236, 8vo, 7¾ × 5¼. (New York: The Macmillan Co., 1921.) Price 13*s*.

This little handbook is written by an enthusiast in a style that is characteristically American. It is divided into three parts. In the first part, which is headed "General Notes," the author sets forth reasons for the extension of nut-culture, which he claims to be more remunerative than ordinary agriculture, especially on hilly lands. He emphasises the value of nuts as food, and points out the need for co-operation amongst the nut-growers in marketing their crops and for adopting standard varieties for cultivation. The varieties of nut trees most esteemed for cultivation in the United States, termed by the author the "Big Four," are the pecan in the south, the shagbark hickory in the north-east, the black walnut in the central west, and the Persian walnut on the Pacific Coast. In Part II, seeds, soils, transplanting and grafting are dealt with. As the cultivated kinds of walnuts, pecans and hickories do not come true from seed, the need for grafting is obvious, and for this reason a full and detailed account of grafting methods, with graphic illustrations of the various processes, form the most valuable feature. The grafting of nut trees by the ordinary methods is not very successful, and after numerous experiments by various operators in different parts of the United States, the author claims to have discovered a method which has proved uniformly successful. "In fact," he states, "it appears to have changed the entire subject of grafting in such a way that almost anyone employing this method may now do any sort of tree grafting." The method referred to consists in employing melted paraffin wax instead of opaque, coloured grafting waxes, which are commonly used for this purpose, and in covering with the wax, not only the point of union, but the whole of the scion, buds and all, as well as the wound in the stock, and the wrappings. The success of this material is supposed to be due to the fact that it is translucent and admits certain light rays to the tissues, whilst at the

same time it rejects heat rays and prevents evaporation. Concluding chapters of this part deal with hybridising for raising new varieties, and the care of nut orchards, including pruning and the prevention of fungus and insect enemies. The third part of the book deals with the species and varieties of nuts cultivated in the United States, including hickories, walnuts, hazels, chestnuts, pines, beechnuts, acorns and almonds.

It would have added to the value of the book had the methods of preparation, grading and marketing of the various kinds of nuts mentioned been dealt with, but the contents comply strictly with the title, and deal only with nut-growing. In view of the rather scanty and scattered literature on the subject, the book should prove a useful manual for those who contemplate embarking on this industry.

Condensed Description of the Manufacture of Beet Sugar. By Franz Murke, Ph.D., A.M. Pp. v + 175, 8vo, 8¾ × 5½. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1921.) Price 15s.

The preparation of sugar from beet involves a number of mechanical and technical processes, to describe which in sufficient detail to be intelligible to the non-technical reader would necessitate a lengthy treatise and numerous diagrams. In this little book there are no diagrams, and the descriptive matter treats of the various processes in a general way, and is very much condensed. It follows, therefore, that the language employed is highly technical. Although prepared for publication as long ago as 1903–5, this handbook has not previously been published, but as few developments have taken place in beet sugar manufacture in the interval, it needed few alterations and additions to bring it to its present form. The methods of beet sugar manufacture described are those practised in the United States, and there is little of interest to the general reader or to the grower of sugar-beet. For superintendents, engineers and foremen of beet sugar factories the handbook should prove useful, and the concluding chapter, which gives useful formulæ and tables for various calculations, presents in a convenient form much information of practical value.

Nouveaux Parfums Synthetiques. By R. M. and J. Gattefossé. Pp. 208, 8vo, 9½ × 5¾. (Lyons: Publications Pierre Argence, 1921.) Price 12 fr.

The continual development of the synthetic perfume industry, and the frequent creation of new products, are

cited as the *raison d'être* for the publication of this book, which is not intended to replace more comprehensive volumes on the subject. The work represents the collaboration of the two authors with others associated with the monthly journal *La Parfumerie Moderne.*

The first part of the book is largely of an introductory character, and directs attention to the remarkable progress which has been made during recent years in the chemistry of perfumes and their manufacture, and mentions the notable share contributed in this direction by French chemists. A rough outline of the chemistry of odorous compounds is presented in a simple manner, synthetic perfumes are classified, and the composition is given of floral and fancy perfumes.

The second part of the book deals with the manufacture of synthetic perfume materials: alcohols, acids, esters, phenols, phenol ethers, oxides, hydrocarbons, aldehydes, ketones, artificial musks, indole, and scatole. Special attention is given to important substances. Fifty pages, for example, are devoted to vanillin, containing descriptions of numerous patents for its preparation, synthetically, or from coniferin, eugenol, and guaiacol, and three diagrams of apparatus employed in connection with its manufacture are supplied.

PRACTICAL LEATHER MANUFACTURE: A HANDBOOK OF MODERN PROCESSES OF LEATHER TANNING, DRESSING, DYEING, STAINING, AND FINISHING, ETC. Edited by H. G. Crockett. Pp. ix + 428, 8vo, $8\frac{3}{4} \times 5\frac{1}{2}$. (London: The Leather Trades Publishing Co., Ltd., 1921.) Price 21*s.*

This useful and practical volume has been compiled by the editor of *The Leather World.* It contains, in his opinion, all the best practical matter in connection with the leather industry which has appeared in his journal during the past few years, and in addition many original contributions written specially for the work by practical men and experts in their particular branch of the subject.

The book commences with a short description of the treatment and classification of hides and the soaking of dried hides; a general account of the liming process is then given, which is followed by methods of manufacture of various classes of sole leather and chrome picker bands. One section is devoted to harness, saddlery, belting, upholstery, and motor leathers, and another to the production of upper leathers of different qualities. Under the heading of "Light and Fancy Leathers," a further section deals with a variety of tannages and methods of dyeing and finishing calf, goat, kid, seal, sheep, lamb and

colt skins, and includes imitation antelope, suède, velvet, and patent leathers, jerkin, and chamois leathers. The concluding portion contains useful miscellaneous technical information, including the manufacture of tanning extracts and chrome liquors; colloidal tanning; organic acids in the tannery; spent tan as a fuel; hydro-extractors; leather drying; fur dyeing; sulphonated oils; "dope" enamel finishes; grease, glues and fertilisers from leather waste.

An important feature of the book is the large number of useful recipes given in connection with the various tanning and dyeing operations dealt with.

SYNTHETIC TANNINS: THEIR SYNTHESIS, INDUSTRIAL PRODUCTION AND APPLICATION. By Georg Grasser, Dr. Phil., Ing. Translated by F. G. A. Enna. Pp. viii + 143, 8vo, 8½ × 5¾. (London: Crosby Lockwood & Son, 1922.) Price 12s.

It is only within recent years that synthetic tannins have received serious attention, and, although they are not employed to any great extent to-day, they bid fair to become serious rivals to the natural tannins in the future. The shortage of tanning materials during the war gave an impetus to this department of synthetic chemistry.

The present volume includes the results of the author's investigations during his appointment as technical consultant to the Austrian Hide and Leather Commission, and is intended "to present a picture, complete as far as it goes, of this branch of chemical technology."

The first two sections of the book deal with the synthesis and constitution of the vegetable tannins, and those substances which enter into the composition of synthetic tannins. Many references are made to the important researches which Emil Fischer and his collaborators have carried out during recent years. The remainder of the book is devoted to the production and practical application of synthetic tannins, and includes also a chapter on the estimation of natural and synthetic tannin materials.

ANIMAL PROTEINS. By H. G. Bennett, M.Sc. (Leeds). Pp. xiv + 287, 8vo, 8½ × 5½. (London: Baillière, Tindall & Cox, 1921.) Price 15s.

The title of this book is rather misleading, as by far the greater portion deals with the manufacture of leather—the other animal proteins occupying only eighty pages.

In a short introduction the author discusses the general properties of the proteins, and adopts for this work a classification based on their behaviour towards water. The book is divided into six parts, four of which are devoted to leather. The first part treats with the manufacture of heavy leathers, including sole, belting, harness, and bag leathers ; the raw material and the preparation of the pelt are also discussed at some length, and descriptions are given of the more common vegetable tannins. This is followed by an account of the manufacture of light leathers produced from goatskins, sealskins, sheepskins and calfskins, and also of japanned and enamelled leathers. Another part deals with chrome leather, and with miscellaneous tannages which include alum, fat, oil and formaldehyde tannages. The two concluding parts are devoted to the manufacture of gelatine and glue, and reference is made to miscellaneous proteins, such as animal and fish manure, and silk, and also to by-products of the leather and glue trades. There are, in addition, two short but interesting sections on the evolution of the leather, gelatine and glue industries.

Applied Colloid Chemistry. By Wilder D. Bancroft, Professor of Physical Chemistry at Cornell University. Pp. viii + 345, 8vo, 8½ × 5½. (New York and London: McGraw-Hill Book Company, Inc., 1921.) Price $3.

This is not an account of the applications of colloid chemistry to industry, but deals with general theory and is to be followed by books (not necessarily by the same author) on specific industries. The book contains copious references to experiments, to views of various workers, and to the original literature of the subject. The first part of the book deals with adsorption under various conditions. This is followed by accounts of the Brownian movement, peptisation, and the various methods of preparing colloidal solutions. The book closes with an account of the properties of colloidal solutions, gels, emulsions, foams, fog and smoke, and thickness of surface films. Author and subject indexes are appended.

The work will be of value to the works chemist who wishes to acquire a detailed knowledge of the theories of colloid chemistry. Like all theoretical works on this subject, however, it is disappointing from the point of view of many specific industries. For instance, very little reference is made to non-aqueous solvents, and rubber, the basis of one of the greatest colloid industries, receives very scanty attention.

STANDARDS AND TESTS FOR REAGENT CHEMICALS. By B. L. Murray. Pp. x + 385, 8vo, 9¼ × 6. (New York: D. van Nostrand Co.; London: A. Constable & Co., Ltd., 1920.) Price 18s.

The need for recognised standards of purity for reagent chemicals has been obvious to chemists for many years past, and the present volume may be regarded as a step towards that desired end. Unfortunately there appears to be but little agreement between chemical manufacturers as to what standards are desirable.

The present volume is stated to be the outcome of the author's experience whilst in charge of the control laboratories of Merck & Co. The substances, arranged in alphabetical order, are first described briefly in regard to physical properties, action of light and air, analytical uses, and precautions during storage. Then follows a table giving the author's idea of the maximum permissible limits of probable impurities, methods for their detection, and in some cases for quantitative estimation. The directions for the quantitative tests are somewhat scanty, as would be anticipated in a work covering such a wide range of chemicals.

Although the majority of common chemical reagents are dealt with, there are one or two notable omissions. Thus, for example, no mention is made of hydrogen peroxide or titanium salts. The volume concludes with useful tables showing the relation between the specific gravity and concentration of the common acids, ammonia and methyl alcohol.

This work is a useful contribution to the subject, and should prove of service to chemists, both for standards of purity which they may hope their reagents to attain, and also as indicating pitfalls due to impurities which may occur, when using unfamiliar reagents.

A MANUAL OF DETERMINATIVE MINERALOGY. By C. H. Warren, Ph.D. Pp. ix + 163, 8vo, 7½ × 5. (New York: McGraw-Hill Book Co., Inc., 1921.) Price 12s.

This manual was originally compiled privately for the use of students at the Massachusetts Institute of Technology, because, in the author's opinion, there was no book dealing satisfactorily with the practical side of the question of mineral determination which was suitable for beginners. The system of investigation has worked well for several years in the above Institute in conjunction with the standard descriptive texts. The book contains four chapters. The first, on the use of the blowpipe, etc., gives the methods of procedure for the usual preliminary investigation in the dry way. The second takes the elements

in alphabetical order, and describes the most characteristic and simple tests for detecting the presence of each. The third consists of a tabulated list of useful dry reactions. The fourth commences with general remarks on preliminary observations to be made with a hand lens and on simple physical tests, these being followed by determinative tables, in which all the minerals mentioned are divided into two main groups, those having dark streak or metallic lustre, and those having light streak or non-metallic lustre, after which they are grouped into numerous subdivisions and sections by means of their behaviour before the blow-pipe. The book concludes with an index.

This little book should fulfil a useful purpose, providing as it does an accurate list of determinative reactions which should be of service to students, engineers and prospectors. The work is, however, considerably impaired by a large number of typographical errors.

CONCENTRATION BY FLOTATION. Compiled and edited by T. A. Rickard. Pp. xi + 692, 8vo, 9¼ × 5¾. (New York and London: John Wiley & Sons, Inc., 1921.) Price 42*s*.

This work is a collection of thirty-eight articles by various authors, nearly the whole of which appeared in the *Mining and Scientific Press* during the years 1915 to 1920. Five of the articles were reprinted in *The Flotation Process*, by T. A. Rickard, 1916 (briefly reviewed in this BULLETIN, 1916, **14**, 492); seventeen appeared in *Flotation*, by Rickard and Ralston (1917), while the remaining sixteen articles are more recent matter. The subjects dealt with include the history and principles of flotation, and litigation relating thereto, the theory of the process and its practical working, preferential or differential flotation, the Horwood process as applied to the copper-zinc ore of the Afterthought mine, and the Bradford process as practised at Brook Hill. Other articles deal with the flotation of galena at Broken Hill, of copper ores in California and Utah, and of silver ores at Cobalt, Ontario.

The work cannot be described as a complete treatise on flotation, but it is a useful addition to the literature of that process, a literature which has been rapidly growing in recent years.

METALLIC ALLOYS: THEIR STRUCTURE AND CONSTITUTION. By G. H. Gulliver, D.Sc., F.R.S.E., etc. 4th Edition. Pp. xxviii + 439, 8vo, 8 × 5. (London: Chas. Griffin & Co. Ltd., 1921.) Price 15*s*.

This differs little from the third edition, except that an appendix dealing with the theory of the effects produced

by rapid cooling of alloys has been added. The work appears to be primarily intended for the student of metallography, and hence does not purport to be a treatise on the practical manufacture of alloys.

After describing the methods of investigation employed in order to determine the constitution and structure of the several classes of alloys, the author gives detailed descriptions of the metallographical characteristics of the more important alloys. The descriptive matter is considerably enhanced by the presence of 332 illustrations. The bibliographies at the end of each chapter will prove of assistance to the student.

PRODUCER GAS. By J. Emerson Dowson, M.I.C.E., M.I.M.E., and A. T. Larter, M.B.E., B.Sc. 4th Edition. Pp. xiii + 361, 8vo, $8\frac{3}{4} \times 5\frac{3}{4}$. (London: Longmans, Green & Co., 1920.) Price 21*s.*

During the past few years considerable progress has been made in the utilisation, as fuel for gas producers, of many substances previously considered unsuitable. In the early days of the industry anthracite and coke were the only fuels employed, but now bituminous coal, wood, tan waste, peat, lignite, cotton seed, and other materials are successfully used for the purpose.

The appearance of a new edition of Messrs. Dowson and Larter's well-known work is therefore of interest. After an adequate consideration, from the theoretical standpoint, of the formation of the gas, the authors discuss its practical applications and give descriptions and diagrams of many types of producer gas plant. The succeeding chapters discuss the special features involved in plant and working when using bituminous coal, peat and numerous other fuels. New and interesting features in the present edition are sections on the use of producer gas for road traction purposes and the propulsion of vessels. These uses are still in rather an early stage, but both show promise of development.

Methods for the analysis of fuel and gas are well described. The concluding chapter contains a collection of "practical notes" likely to be of service to users of producer gas plant. The book will continue to be of value to all interested in producer gas.

BOOKS RECEIVED

ARTIFICIAL SILK AND ITS MANUFACTURE. By Joseph Foltzer. Translated from the French by T. Woodhouse. Pp. xi + 244, $8\frac{1}{2} \times 5\frac{3}{4}$. (London: Sir Isaac Pitman & Sons, Ltd., 1921.) Price 21*s.*

FOREST MENSURATION. By Herman Haupt Chapman, M.F. Pp. xxii + 553, $9\frac{1}{2} \times 6$. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1921.) Price 30*s.*

HANDBOOK FOR FIELD GEOLOGISTS. By C. W. Hayes, Ph.D. Third Edition, Revised and Rearranged by Sidney Paige. Pp. xi + 166, $7 \times 4\frac{1}{2}$. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1921.) Price 13*s.* 6*d.*

A MANUAL OF DETERMINATIVE MINERALOGY WITH TABLES FOR THE DETERMINATION OF MINERALS BY MEANS OF: I. Their Physical Characters; II. Blowpipe and Chemical Properties. By J. Volney Lewis. Third Revised and Enlarged Edition. Pp. v + 298, 9×6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1921.) Price 16*s.* 6*d.*

THE ANALYSIS OF COAL AND ITS BY-PRODUCTS. By S. Roy Illingworth, M.Sc. (Lond.), A.R.C.Sc., F.I.C., assisted by Jenkyn Griffiths, F.C.S. Pp. 380, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: The Colliery Guardian Co., Ltd., 1921.) Price 21*s.*

MODERN COKING PRACTICE. By J. E. Christopher; including the ANALYSIS OF MATERIALS AND PRODUCTS. By T. H. Byrom. Third Edition. Volume I. Raw Materials and Coke, pp. xxi + 130; Volume II. By-Products, pp. xxii + 130, $9\frac{1}{2} \times 6$. (London: Crosby, Lockwood & Son, 1921.) Price 10*s.* 6*d.* per volume.

A MANUAL OF FLOTATION PROCESSES. By Arthur F. Taggart. Pp. xv + 181, 9×6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1921.) Price 16*s.* 6*d.*

VOL. XIX, 1921

INDEX

Botanical and entomological names and titles of books are printed in italics and authors' names in capitals

Printed by Hazell, Watson & Viney, Ld., London and Aylesbury, England.